Configuring QoS

This chapter provides details on the QoS features provided in all switches.

Quality of service (QoS) offers the following advantages:

- Provides relative bandwidth guarantee to application traffic.
- Controls latency experienced by application traffic.
- Prioritizes one application over another (for example, prioritizing transactional traffic over bulk traffic) through bandwidth and latency differentiation.

Information About Control Traffic

The Cisco MDS 9000 Series supports QoS for internally and externally generated control traffic. Within a switch, control traffic is sourced to the supervisor module and is treated as a high priority frame. A high priority status provides absolute priority over all other traffic and is assigned in the following cases:

- Internally generated time-critical control traffic (mostly Class F frames).

- Externally generated time-critical control traffic entering a switch in the Cisco MDS 9000 Series from a another vendor's switch. High priority frames originating from other vendor switches are marked as high priority as they enter a switch in the Cisco MDS 9000 Series.

Enabling or Disabling Control Traffic

By default, the QoS feature for certain critical control traffic is enabled. These critical control frames are assigned the highest (absolute) priority.

Tip We do not recommend disabling this feature as all critical control traffic is automatically assigned the lowest priority once you issue this command.

To disable the high priority assignment for control traffic, follow these steps:

Step 1 Enters configuration mode.

switch# **configure terminal**

Step 2 Enables the control traffic QoS feature.

switch(config)# **no qos control priority 0**

Step 3 Disables the control traffic QoS feature.

switch(config)# **qos control priority 0**

Displaying Control Traffic Information

Use the **show qos statistics** command to view the current state of the QoS configuration for critical control traffic. This command displays the current QoS settings along with the number of frames marked high priority. The count is only for debugging purposes and cannot be configured.

The following example displays Current QoS Settings

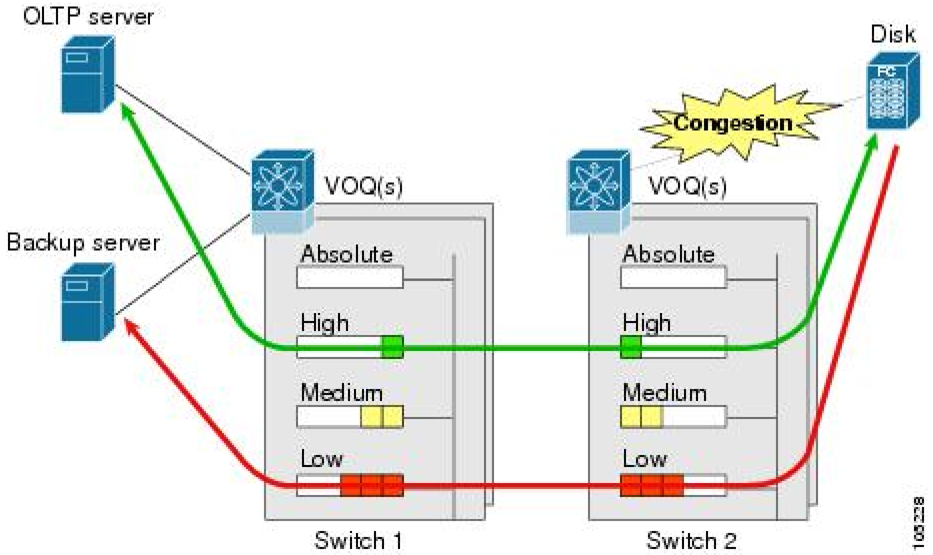
```
switch# show qos statistics
Total number of FC frames transmitted from the Supervisor= 15767
Number of highest-priority FC frames transmitted         = 8224
Current priority of FC control frames = 0    (0 = lowest; 7 = highest)
```

Information About Data Traffic

Online transaction processing (OLTP), which is a low volume, latency sensitive application, requires quick access to requested information. Backup processing application require high bandwidth but are not sensitive to latency. In a network that does not support service differentiation, all traffic is treated identically—they experience similar latency and are allocated similar bandwidths. The QoS feature in the Cisco MDS 9000 Series switches provides these guarantees.

Data traffic can be prioritized in distinct levels of service differentiation: low, medium, or high priority. You can apply QoS to ensure that Fibre Channel data traffic for your latency-sensitive applications receive higher priority over throughput-intensive applications such as data warehousing.

Figure 1: Prioritizing Data Traffic



In the above figure, the OLTP traffic arriving at Switch 1 is marked with a high priority level of throughput classification (class map) and marking (policy map). Similarly, the backup traffic is marked with a low priority level. The traffic is sent to the corresponding priority queue within a virtual output queue (VOQ).

A deficit weighted round robin (DWRR) scheduler configured in the first switch ensures that high priority traffic is treated better than low priority traffic. For example, DWRR weights of 70:20:10 implies that the high priority queue is serviced at 7 times the rate of the low priority queue. This guarantees lower delays and higher bandwidths to high priority traffic if congestion sets in. A similar configuration in the second switch ensures the same traffic treatment in the other direction.

If the ISL is congested when the OLTP server sends a request, the request is queued in the high priority queue and is serviced almost immediately since the high priority queue is not congested. The scheduler assigns its priority over the backup traffic in the low priority queue.

Note When the high priority queue does not have traffic flowing through, the low priority queue uses all the bandwidth and is not restricted to the configured value.

A similar occurrence in Switch 2 sends a response to the transaction request. The round trip delay experienced by the OLTP server is independent of the volume of low priority traffic or the ISL congestion. The backup traffic uses the available ISL bandwidth when it is not used by the OLTP traffic.

Comparing VSAN Versus Zone-Based QoS

While you can configure both zone-based QoS and VSAN-based QoS configurations in the same switch, both configurations have significant differences. The following table highlights the differences between configuring QoS priorities based on VSANs versus zones.

Table 1: QoS Configuration Differences

VSAN-Based QoS	Zone-Based QoS
If you configure the active zone set on a given VSAN and also configure QoS parameters in any of the member zones, you cannot associate the policy map with the VSAN.	You cannot activate a zone set on a VSAN that already has a policy map associated.
If the same flow is present in two class maps associated to a policy map, the QoS value of the class map attached first takes effect.	If the same flow is present in two zones in a given zone set with different QoS values, the higher QoS value is considered.
—	During a zone merge, if the Cisco NX-OS software detects a mismatch for the QoS parameter, the link is isolated.
Takes effect only when QoS is enabled.	Takes effect only when QoS is enabled.

Configuring Data Traffic

To configure QoS, follow these steps:

Step 1 Enable the QoS feature.

Step 2 Create and define class maps.

Step 3 Define service policies.

Step 4 Apply the configuration.

QoS Initiation for Data Traffic

By default, the QoS data traffic feature is disabled for data traffic. To configure QoS for data traffic, you must first enable the data traffic feature in the switch.

Tip QoS is supported in interoperability mode. For more information, refer to the *Cisco MDS 9000 Series Switch-to-Switch Interoperability Configuration Guide* .

To enable the QoS data traffic feature, follow these steps:

Step 1 Enters configuration mode.

switch# **configure terminal**

Step 2 Enables QoS. You can now configure data traffic parameters.

switch(config)# **qos enable**

Information About Class Map Creation

Use the class map feature to create and define a traffic class with match criteria to identify traffic belonging to that class. The class map name is restricted to 63 alphanumeric characters and defaults to the match-all option. Flow-based traffic uses one of the following values:

- WWN—The source WWN or the destination WWN.
- Fibre Channel ID (FC ID) —The source ID (SID) or the destination ID (DID). The possible values for mask are FFFFFF (the entire FC ID is used—this is the default), FFFF00 (only domain and area FC ID is used), or FF0000 (only domain FC ID is used).

Note An SID or DID of 0x000000 is not allowed.

- Source interface—The ingress interface.

Tip The order of entries to be matched within a class map is not significant.

Creating a Class Map

Use the **class-map** command to create and define a traffic class with match criteria to identify traffic belonging to that class. Define each match criterion with one match statement from the class map configuration (switch(config-cmap)) mode.

Note The enhanced mode for the **source-device-alias** or **destination-device-alias** option is not supported.

Note The QoS attribute with IVR zone set and VSAN is not supported.

- Use the **source-wwn** option to specify the source WWN or the **destination-wwn** option to specify the destination WWN.

- Use the **source-address** option to specify the source ID (SID) or the **destination-address** option to specify the destination ID (DID).
- Use the **input-interface** option to specify the ingress interface.
- Use the **destination-device-alias** option to specify the distributed device alias.

To create a class map, follow these steps:

Step 1 Specifies a logical AND operator for all matching statements in this class. If a frame matches all (default) configured criteria, it qualifies for this class. This is the default.

```
switch(config)# qos class-map MyClass match-all
```

Step 2 Specifies a logical OR operator for all matching statements in this class. If a frame matches any one configured criteria, it qualifies for this class.

```
switch(config)# qos class-map MyClass match-any
```

Step 3 Specifies a destination address match for frames with the specified destination FC ID.

```
switch(config-cmap)# match destination-address 0x12ee00
```

Step 4 Specifies a source address and mask match for frames with the specified source FC ID.

```
switch(config-cmap)# match source-address 0x6d1090 mask 0xFFFFFF
```

Step 5 Specifies a destination WWN to match frames.

```
switch(config-cmap)# match destination-wwn 20:01:00:05:30:00:28:df
```

Step 6 Specifies a source WWN to match frames.

```
switch(config-cmap)# match source-wwn 23:15:00:05:30:00:2a:1f
```

Step 7 Specifies a destination device alias to match frames.

```
switch(config-cmap)# match destination-device-alias DocDeviceAlias
```

Step 8 Specifies a source device alias to match frames.

```
switch(config-cmap)# match source-device-alias DocDeviceAliase
```

Step 9 Specifies a source interface to match frames.

```
switch(config-cmap)# match input-interface fc 2/1
```

Step 10 Removes a match based on the specified source interface.

```
switch(config-cmap)# no match input-interface fc 3/5
```

Information About Service Policy Definition

Service policies are specified using policy maps. Policy maps provide an ordered mapping of class maps to service levels. You can specify multiple class maps within a policy map, and map a class map to a high, medium, or low service level. The default priority is low. The policy map name is restricted to 63 alphanumeric characters.

As an alternative, you can map a class map to a differentiated services code point (DSCP).The DSCP is an indicator of the service level for a specified frame. The DSCP value ranges from 0 to 63, and the default is 0. A DSCP value of 46 is disallowed.

The order of the class maps within a policy map is important to determine the order in which the frame is compared to class maps. The first matching class map has the corresponding priority marked in the frame.

Note For more information on implementing QoS DSCP values, see the following document: *Implementing Quality of Service Policies with DSCP*.

Note Class maps are processed in the order in which they are configured in each policy map.

Specifying Service Policies

To specify a service policy, follow these steps:

Step 1 Creates a policy map called MyPolicy and places you in the policy-map submode.

```
switch(config)# qos policy-map MyPolicy
switch(config-pmap)#
```

Step 2 Deletes the policy map called OldPolicy and places you in the policy-map submode.

```
switch(config)# no qos policy-map OldPolicy
```

Step 3 Specifies the name of a predefined class and places you at the policy-map submode for that class.

```
switch(config-pmap)# class MyClass
switch(config-pmap-c)#
```

Step 4 Removes the class map called OldClass from the policy map.

```
switch(config-pmap)# no class OldClass
```

Step 5 Specifies the priority to be given for each frame matching this class.

```
switch(config-pmap-c)# priority high
```

Step 6 Deletes a previously assigned priority and reverts to the default value of low.

```
switch(config-pmap-c)# no priority high
```

Step 7 Specifies the DSCP value to mark each frame matching this class.

```
switch(config-pmap-c)# dscp 2
```

Step 8 Deletes a previously assigned DSCP value and reverts to the factory default of 0.

```
switch(config-pmap-c)# no dscp 60
```

About Service Policy Enforcement

When you have configured a QoS data traffic policy, you must enforce the data traffic configuration by applying that policy to the required VSAN(s). If you do not apply the policy to a VSAN, the data traffic configuration is not enforced. You can only apply one policy map to a VSAN.

Note You can apply the same policy to a range of VSANs.

Applying Service Policies

To apply a service policy, follow these steps:

Step 1 Applies a configured policy to VSAN 3.

```
switch(config)# qos service policy MyPolicy vsan 3
```

Step 2 Deletes a configured policy that was applied to VSAN 7.

```
switch(config)# no qos service policy OldPolicy vsan 7
```

About the DWRR Traffic Scheduler Queue

The Cisco NX-OS software supports four scheduling queues:

- Strict priority queues are queues that are serviced in preference to other queues—it is always serviced if there is a frame queued in it regardless of the state of the other queues.
- QoS assigns all other traffic to the DWRR scheduling high, medium, and low priority traffic queues.

The DWRR scheduler services the queues in the ratio of the configured weights. Higher weights translate to proportionally higher bandwidth and lower latency. The default weights are 50 for the high queue, 30 for the medium queue, and 20 for the low queue. Decreasing order of queue weights is mandated to ensure the higher priority queues have a higher service level, though the ratio of the configured weights can vary (for example, one can configure 70:30:5 or 60:50:10 but not 50:70:10).

Note Generation 1 and Generation 2 modules are not supported from Cisco MDS NX-OS Release 6.x and later. Generation 3 and Generation 4 modules are not supported from Cisco MDS NX-OS Release 8.x and later.

For more information on the modules and ports supported, refer the Cisco MDS 9000 Series Interface Configuration Guide, Release 8.x guide.

Changing the Weight in a DWRR Queue

To associate a weight with a DWRR queue, follow these steps:

Step 1 Associates a relative weight (10) to a specified queue (default queue).

switch(config)# **qos dwrr-q high weight 10**

Step 2 Restores the default weight of 20.

switch(config)# **no qos dwrr-q low weight 51**

Displaying Data Traffic Information Examples

The **show qos** commands display the current QoS settings for data traffic (see the following examples).

Example: Class Maps

The following example displays the Contents of all Class Maps

```
switch# show qos class-map
qos class-map MyClass match-any
    match destination-wwn 20:01:00:05:30:00:28:df
    match source-wwn 23:15:00:05:30:00:2a:1f
    match input-interface fc2/1
qos class-map Class2 match-all
    match input-interface fc2/14
qos class-map Class3 match-all
    match source-wwn 20:01:00:05:30:00:2a:1f
```

Example: Specified Class Map

The following example displays the Contents of a Specified Class Map:

```
switch# show qos class-map name MyClass
qos class-map MyClass match-any
    match destination-wwn 20:01:00:05:30:00:28:df
    match source-wwn 23:15:00:05:30:00:2a:1f
    match input-interface fc2/1
```

Example: All Configured Policy Maps

The following example displays All Configured Policy Maps:

```
switch# show qos policy-map
qos policy-map MyPolicy
    class MyClass
    priority medium
qos policy-map Policy1
    class Class2
    priority low
```

Example: Specified Policy Map

The following example displays a Specified Policy Map:

```
switch# show qos policy-map name MyPolicy
qos policy-map MyPolicy
    class MyClass
        priority medium
```

Example: Scheduled DWRR Configurations

The following example displays Scheduled DWRR Configurations:

```
switch# show qos dwrr
qos dwrr-q high weight 50
qos dwrr-q medium weight 30
qos dwrr-q low weight 20
```

Example: All Applied Policy Maps

The following example displays All Applied Policy Maps:

```
switch# show qos service policy
qos service policy MyPolicy vsan 1
qos service policy Policy1 vsan 4
```

Example: Policy Map Associated with a Specified VSAN

The following example displays the Policy Map Associated with a Specified VSAN:

```
switch# show qos service policy vsan 1
qos policy-map pmap1
   class cmap1
       priority medium
   class cmap2
       priority high
```

Example: Class Map Associated with a Specified Interface

The following example displays the Class Map Associated with a Specified Interface:

```
switch# show qos service policy interface fc3/10
qos policy-map pmap1
   class cmap3
       priority high
   class cmap4
       priority low
```

Example: QoS Statistics

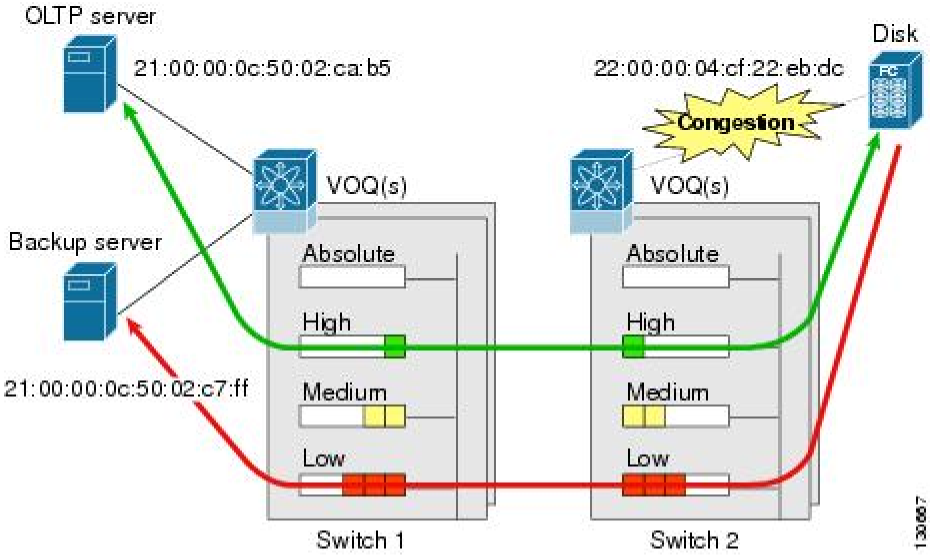
The following example displays QoS Statistics:

```
switch# show qos statistics
Total number of FC frames transmitted from the Supervisor= 301431
Number of highest-priority FC frames transmitted         = 137679
Current priority of FC control frames = 7    (0 = lowest; 7 = highest)
```

Configuration Examples for QoS

This section describes a configuration example for the application illustrated in the following figure.

Figure 2: Example Application for Traffic Prioritization



Both the OLTP server and the backup server are accessing the disk. The backup server is writing large amounts of data to the disk. This data does not require specific service guarantees. The volumes of data generated by the OLTP server to the disk are comparatively much lower but this traffic requires faster response because transaction processing is a low latency application.

The point of congestion is the link between Switch 2 and the disk, for traffic from the switch to the disk. The return path is largely uncongested as there is little backup traffic on this path.

Service differentiation is needed at Switch 2 to prioritize the OLTP-server-to-disk traffic higher than the backup-server-to-disk traffic.

Example: Traffic Prioritization

To configure traffic prioritization for the example application, follow these steps:

Step 1 Create the class maps.

```
Switch 2# config t
Switch 2(config)# qos class-map jc1 match-all
Switch 2(config-cmap)# match source-wwn 21:00:00:0c:50:02:ca:b5
Switch 2(config-cmap)# match destination-wwn 22:00:00:04:cf:22:eb:dc
Switch 2(config-cmap)# exit
Switch 2(config)# qos class-map jc2 match-all
Switch 2(config-cmap)# match source-wwn 21:00:00:0c:50:02:c7:ff
Switch 2(config-cmap)# match destination-wwn 22:00:00:04:cf:22:eb:dc
Switch 2(config-cmap)# exit
Switch 2(config)#
```

Step 2 Create the policy map.

```
Switch 2(config)# qos policy-map jp1
Switch 2(config-pmap)# class jc1
Switch 2(config-pmap-c)# priority high
Switch 2(config-pmap-c)# exit
Switch 2(config-pmap)# class jc2
Switch 2(config-pmap-c)# priority low
Switch 2(config-pmap-c)# exit
Switch 2(config-pmap)# exit
Switch 2(config)#
```

Step 3 Assign the service policy.

```
Switch 2(config)# qos service policy jp1 vsan 1
```

Step 4 Assign the weights for the DWRR queues.

```
Switch 2(config)# qos dwrr-q high weight 50
Switch 2(config)# qos dwrr-q medium weight 30
Switch 2(config)# qos dwrr-q low weight 20
```

Step 5 Repeat Step 1 through Step 4 on Switch 1 to address forward path congestion at both switches.

Example: Address Congestion

Congestion could occur anywhere in the example configuration. To address congestion of the return path at both switches, you need to create two more class maps and include them in the policy map as follows:

Step 1 Create two more class maps.

```
Switch 2(config)# qos class-map jc3 match-all
Switch 2(config-cmap)# match source-wwn 22:00:00:04:cf:22:eb:dc
Switch 2(config-cmap)# match destination-wwn 21:00:00:0c:50:02:ca:b5
Switch 2(config-cmap)# exit
Switch 2(config)# qos class-map jc4 match-all
Switch 2(config-cmap)# match source-wwn 22:00:00:04:cf:22:eb:dc
Switch 2(config-cmap)# match destination-wwn 21:00:00:0c:50:02:c7:ff
Switch 2(config-cmap)# exit
Switch 2(config)#
```

Step 2 Assign the class maps to the policy map.

```
Switch 2(config)# qos policy-map jp1
Switch 2(config-pmap)# class jc3
Switch 2(config-pmap-c)# priority high
Switch 2(config-pmap-c)# exit
Switch 2(config-pmap)# class jc4
Switch 2(config-pmap-c)# priority low
Switch 2(config-pmap-c)# exit
Switch 2(config-pmap)# exit
Switch 2(config)#
```

Step 3 Repeat Step 1 through Step 2 on Switch 1 to address return path congestion at both switches.

Static Ingress Port Rate Limiting

A static port rate limiting feature helps control the bandwidth for individual Fibre Channel ports using the **switchport ingress-rate** *limit* command. Port rate limiting is also referred to as ingress rate limiting because it controls ingress traffic into a Fibre Channel port. The feature controls traffic flow by slowing the rate of B2B credits transmitted from the FC port to the adjacent device. Port rate limiting works on all Fibre Channel ports. Prior to Cisco MDS NX-OS Release 8.5(1), the rate limit ranges from 1 to 100%. From Cisco MDS NX-OS Release 8.5(1), the limit ranges from 0.0126 to 100%. The default rate limit is 100%.

Starting from Cisco MDS NX-OS Release 8.5(1), the FPM feature needs to be configured before configuring the dynamic or static ingress port rate limiting feature on all Cisco MDS switches except Cisco MDS 9250i and MDS 9148S switches. Prior to Cisco MDS NX-OS Release 8.5(1) or on Cisco MDS 9250i and MDS 9148S switches, static ingress port rate limiting can be configured on all Cisco MDS switches and modules only if the QoS feature is enabled.

To configure the port rate limiting value, follow these steps:

Step 1 Enters the configuration mode.

switch # **configure terminal**

switch(config)#

Step 2 Selects the interface to specify the ingress port rate limit.

switch(config)# **interface fc 1/1**

Step 3 Configures a 50% port rate limit for the selected interface.

switch(config-if)# **switchport ingress-rate 50**

Step 4 Reverts a previously configured rate to the factory default of 100%.

```
switch(config-if)# no switchport ingress-rate 50
```