IPv6 QoS: MQC Packet Marking/Remarking

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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

Information About IPv6 QoS: MQC Packet Marking/Remarking

Implementation Strategy for QoS for IPv6

IPv6 packets are forwarded by paths that are different from those for IPv4. QoS features supported for IPv6 environments include packet classification, queueing, traffic shaping, weighted random early detection (WRED), class-based packet marking, and policing of IPv6 packets. These features are available at both the process switching and Cisco Express Forwarding switching paths of IPv6.

All of the QoS features available for IPv6 environments are managed from the modular QoS command-line interface (MQC). The MQC allows you to define traffic classes, create and configure traffic policies (policy maps), and then attach those traffic policies to interfaces.
To implement QoS in networks running IPv6, follow the same steps that you would follow to implement QoS in networks running only IPv4. At a very high level, the basic steps for implementing QoS are as follows:

- Know which applications in your network need QoS.
- Understand the characteristics of the applications so that you can make decisions about which QoS features would be appropriate.
- Know your network topology so that you know how link layer header sizes are affected by changes and forwarding.
- Create classes based on the criteria you establish for your network. In particular, if the same network is also carrying IPv4 traffic along with IPv6, decide if you want to treat both of them the same way or treat them separately and specify match criteria accordingly. If you want to treat them the same, use match statements such as `match precedence`, `match dscp`. If you want to treat them separately, add match criteria such as `match protocol ip` and `match protocol ipv6` in a match-all class map.
- Create a policy to mark each class.
- Work from the edge toward the core in applying QoS features.
- Build the policy to treat the traffic.
- Apply the policy.

**Policies and Class-Based Packet Marking in IPv6 Networks**

You can create a policy to mark each class of traffic with appropriate priority values, using either DSCP or precedence. Class-based marking allows you to set the IPv6 precedence and DSCP values for traffic management. The traffic is marked as it enters the router on the ingress interface. The markings are used to treat the traffic (forward, queue) as it leaves the router on the egress interface. Always mark and treat the traffic as close as possible to its source.

**Traffic Policing in IPv6 Environments**

Congestion management for IPv6 is similar to IPv4, and the commands used to configure queueing and traffic shaping features for IPv6 environments are the same commands as those used for IPv4. Traffic shaping allows you to limit the packet dequeue rate by holding additional packets in the queues and forwarding them as specified by parameters configured for traffic shaping features. Traffic shaping uses flow-based queueing by default. CBWFQ can be used to classify and prioritize the packets. Class-based policer and generic traffic shaping (GTS) or Frame Relay traffic shaping (FRTS) can be used for conditioning and policing traffic.

**How to Specify IPv6 QoS: MQC Packet Marking/Remarking**

**Specifying Marking Criteria for IPv6 Packets**

Perform this task to establish the match criteria (or mark the packets) to be used to match packets for classifying network traffic.
SUMMARY STEPS

1. enable
2. configure terminal
3. policy map policy-map-name
4. class {class-name | class-default}

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables such as privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 3 policy map policy-map-name</td>
<td>Creates a policy map using the specified name and enters QoS policy-map configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter name of policy map you want to create.</td>
</tr>
<tr>
<td>Step 4 class {class-name</td>
<td>class-default}</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>

Configuration Examples for IPv6 QoS: MQC Packet Marking/Remarking

Example: Verifying Packet Marking Criteria

The following example shows how to use the match precedence command to manage IPv6 traffic flows:

Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# class-m cl
To verify that packet marking is working as expected, use the `show policy` command. The output of this command shows a difference in the number of total packets versus the number of packets marked.

```
Router# show policy p1
Policy Map p1
   Class cl
      police 10000 1500 1500 conform-action set-prec-transmit 4 exceed-action drop
```

During periods of transmit congestion at the outgoing interface, packets arrive faster than the interface can send them. It is helpful to know how to interpret the output of the `show policy-map interface` command, which is useful for monitoring the results of a service policy created with Cisco’s MQC.

```
Router# show atm vc 3
ATM5/0.2: VCD: 3, VPI: 2, VCI: 2
VBR-NRT, PeakRate: 30000, Average Rate: 20000, Burst Cells: 94
AAL5-LLC/SNAP, etype:0x0, Flags: 0x20, VCmode: 0x0
OAM frequency: 0 second(s)
PA TxRingLimit: 10
InARP frequency: 15 minutes(s)
Transmit priority 2
InPkts: 0, OutPkts: 0, InBytes: 0, OutBytes: 0
InProc: 0, OutProc: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
OAM cells received: 0
OAM cells sent: 0
Status: UP
```

Cisco software (also referred to as the Layer 3 processor) and the interface driver use the transmit ring when moving packets to the physical media. The two processors collaborate in the following way:

- The interface sends packets according to the interface rate or a shaped rate.
• The interface maintains a hardware queue or transmit ring, where it stores the packets waiting for transmission onto the physical wire.

• When the hardware queue or transmit ring fills, the interface provides explicit back pressure to the Layer 3 processor system. It notifies the Layer 3 processor to stop dequeuing packets to the interface’s transmit ring because the transmit ring is full. The Layer 3 processor now stores the excess packets in the Layer 3 queues.

• When the interface sends the packets on the transmit ring and empties the ring, it once again has sufficient buffers available to store the packets. It releases the back pressure, and the Layer 3 processor dequeues new packets to the interface.

The most important aspect of this communication system is that the interface recognizes that its transmit ring is full and throttles the receipt of new packets from the Layer 3 processor system. Thus, when the interface is congested, the drop decision is moved from a random, last-in, first-dropped decision in the first in, first out (FIFO) queue of the transmit ring to a differentiated decision based on IP-level service policies implemented by the Layer 3 processor.

Service policies apply only to packets stored in the Layer 3 queues. The table below illustrates which packets sit in the Layer 3 queue. Locally generated packets are always process switched and are delivered first to the Layer 3 queue before being passed on to the interface driver. Fast-switched and Cisco Express Forwarding-switched packets are delivered directly to the transmit ring and sit in the L3 queue only when the transmit ring is full.

Table 1: Packet Types and the Layer 3 Queue

<table>
<thead>
<tr>
<th>Packet Type</th>
<th>Congestion</th>
<th>Noncongestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally generated packets, including Telnet packets and pings</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Other packets that are process switched</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Packets that are Cisco Express Forwarding- or fast-switched</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

The following example shows these guidelines applied to the `show policy-map interface` command output.

```
Router# show policy-map interface atm 1/0.1

ATM1/0.1: VC 0/100 -
Service-policy output: cbwfq (1283)
  Class-map: A (match-all) (1285/2)
    28621 packets, 7098008 bytes
    5 minute offered rate 10000 bps, drop rate 0 bps
    Match: access-group 101 (1289)
    Weighted Fair Queueing
    Output Queue: Conversation 73
    Bandwidth 500 (kbps) Max Threshold 64 (packets)
    (pkts matched/bytes matched) 28621/7098008

    (depth/total drops/no-buffer drops) 0/0/0
  Class-map: B (match-all) (1301/4)
    2058 packets, 148176 bytes
```
5 minute offered rate 0 bps, drop rate 0 bps
Match: access-group 103 (1305)
Weighted Fair Queueing
Output Queue: Conversation 75
Bandwidth 50 (kbps) Max Threshold 64 (packets)
(pkt matched/bytes matched) 0/0
(depth/total drops/no-buffer drops) 0/0/0
Class-map: class-default (match-any) (1309/0)
19 packets, 968 bytes
5 minute offered rate 0 bps, drop rate 0 bps
Match: any (1313)

The table below defines counters that appear in the example.

Table 2: Packet Counters from show policy-map interface Output

<table>
<thead>
<tr>
<th>Counter</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>28621 packets, 7098008 bytes</td>
<td>The number of packets matching the criteria of the class. This counter increments whether or not the interface is congested.</td>
</tr>
<tr>
<td>(pkt matched/bytes matched) 28621/709800</td>
<td>The number of packets matching the criteria of the class when the interface was congested. In other words, the interface’s transmit ring was full, and the driver and the L3 processor system worked together to queue the excess packets in the L3 queues, where the service policy applies. Packets that are process switched always go through the L3 queuing system and therefore increment the &quot;packets matched&quot; counter.</td>
</tr>
<tr>
<td>Class-map: B (match-all) (1301/4)</td>
<td>These numbers define an internal ID used with the CISCO-CLASS-BASED-QOS-MIB Management Information Base (MIB).</td>
</tr>
<tr>
<td>5 minute offered rate 0 bps, drop rate 0 bps</td>
<td>Use the load-interval command to change this value and make it a more instantaneous value. The lowest value is 30 seconds; however, statistics displayed in the show policy-map interface command output are updated every 10 seconds. Because the command effectively provides a snapshot at a specific moment, the statistics may not reflect a temporary change in queue size.</td>
</tr>
</tbody>
</table>

Without congestion, there is no need to queue any excess packets. When congestion occurs, packets, including Cisco Express Forwarding- and fast-switched packets, might go into the Layer 3 queue. If you use congestion management features, packets accumulating at an interface are queued until the interface is free to send them; they are then scheduled according to their assigned priority and the queueing mechanism configured for the interface.

Normally, the packets counter is much larger than the packets matched counter. If the values of the two counters are nearly equal, then the interface is receiving a large number of process-switched packets or is heavily congested. Both of these conditions should be investigated to ensure optimal packet forwarding.
Routers allocate conversation numbers for the queues that are created when the service policy is applied. The following example shows the queues and related information.

Router# show policy-map interface s1/0.1 dlci 100

Serial1/0.1: DLCI 100 -
output: mypolicy
Class voice
Weighted Fair Queueing
Strict Priority
Output Queue: Conversation 72
  Bandwidth 16 (kbps) Packets Matched 0
  (pkts discards/bytes discards) 0/0
Class immediate-data
Weighted Fair Queueing
Output Queue: Conversation 73
  Bandwidth 60 (%) Packets Matched 0
  (pkts discards/bytes discards/tail drops) 0/0/0
  mean queue depth: 0
  drops: class random tail min-th max-th mark-prob
  0 0 0 64 128 1/10
  1 0 0 71 128 1/10
  2 0 0 78 128 1/10
  3 0 0 85 128 1/10
  4 0 0 92 128 1/10
  5 0 0 99 128 1/10
  6 0 0 106 128 1/10
  7 0 0 113 128 1/10
  rsvp 0 0 120 128 1/10
Class priority-data
Weighted Fair Queueing
Output Queue: Conversation 74
  Bandwidth 40 (%) Packets Matched 0
  Max Threshold 64 (packets)
  (pkts discards/bytes discards/tail drops) 0/0/0
Class class-default
Weighted Fair Queueing
Flow Based Fair Queueing
  Maximum Number of Hashed Queues 64
  Max Threshold 20 (packets)

Information reported for each class includes the following:

- Class definition
- Queueing method applied
- Output Queue Conversation number
- Bandwidth used
- Number of packets discarded
- Number of bytes discarded
- Number of packets dropped

The class-default class is the default class to which traffic is directed, if that traffic does not satisfy the match criteria of other classes whose policy is defined in the policy map. The fair-queue command allows you to specify the number of dynamic queues into which IP flows are sorted and classified. Alternately, routers allocate a default number of queues derived from the bandwidth on the interface or VC. Supported values in either case are a power of two, in a range from 16 to 4096.

The table below lists the default values for interfaces and for ATM permanent virtual circuits (PVCs).
**Table 3: Default Number of Dynamic Queues as a Function of Interface Bandwidth**

<table>
<thead>
<tr>
<th>Bandwidth Range</th>
<th>Number of Dynamic Queues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 64 kbps</td>
<td>16</td>
</tr>
<tr>
<td>More than 64 kbps and less than or equal to 128 kbps</td>
<td>32</td>
</tr>
<tr>
<td>More than 128 kbps and less than or equal to 256 kbps</td>
<td>64</td>
</tr>
<tr>
<td>More than 256 kbps and less than or equal to 512 kbps</td>
<td>128</td>
</tr>
<tr>
<td>More than 512 kbps</td>
<td>256</td>
</tr>
</tbody>
</table>

The table below lists the default number of dynamic queues in relation to ATM PVC bandwidth.

**Table 4: Default Number of Dynamic Queues as a Function of ATM PVC Bandwidth**

<table>
<thead>
<tr>
<th>Bandwidth Range</th>
<th>Number of Dynamic Queues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 128 kbps</td>
<td>16</td>
</tr>
<tr>
<td>More than 128 kbps and less than or equal to 512 kbps</td>
<td>32</td>
</tr>
<tr>
<td>More than 512 kbps and less than or equal to 2000 kbps</td>
<td>64</td>
</tr>
<tr>
<td>More than 2000 kbps and less than or equal to 8000 kbps</td>
<td>128</td>
</tr>
<tr>
<td>More than 8000 kbps</td>
<td>256</td>
</tr>
</tbody>
</table>

Based on the number of reserved queues for WFQ, Cisco software assigns a conversation or queue number as shown in the table below.

**Table 5: Conversation Numbers Assigned to Queues**

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 256</td>
<td>General flow-based traffic queues. Traffic that does not match to a user-created class will match to class-default and one of the flow-based queues.</td>
</tr>
<tr>
<td>Number</td>
<td>Type of Traffic</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>257 to 263</td>
<td>Reserved for Cisco Discovery Protocol and for packets marked with an internal high-priority flag.</td>
</tr>
<tr>
<td>264</td>
<td>Reserved queue for the priority class (classes configured with the priority command). Look for the &quot;Strict Priority&quot; value for the class in the show policy-map interface output. The priority queue uses a conversation ID equal to the number of dynamic queues, plus 8.</td>
</tr>
<tr>
<td>265 and higher</td>
<td>Queues for user-created classes.</td>
</tr>
</tbody>
</table>

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 addressing and connectivity</td>
<td>IPv6 Configuration Guide</td>
</tr>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>IPv6 commands</td>
<td>Cisco IOS IPv6 Command Reference</td>
</tr>
<tr>
<td>Cisco IOS IPv6 features</td>
<td>Cisco IOS IPv6 Feature Mapping</td>
</tr>
<tr>
<td>Marking Network Traffic</td>
<td>&quot;Marking Network Traffic&quot; module</td>
</tr>
</tbody>
</table>

#### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFCs for IPv6</td>
<td>IPv6 RFCs</td>
</tr>
</tbody>
</table>
MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for IPv6 QoS: MQC Packet Marking/Remarking

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

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

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 QoS: MQC Packet Marking/Remarking</td>
<td>Cisco IOS XE Release 2.1</td>
<td>Class-based marking allows you to set the IPv6 precedence and DSCP values for traffic management.</td>
</tr>
</tbody>
</table>