Configuring Hierarchical Modular QoS

Hierarchical QoS (H-QoS) is a QoS model that enables you to specify QoS behavior at multiple levels of hierarchy. This chapter provides information about this feature and the different steps involved in configuring it.

Table 1: Feature History for Hierarchical Modular QoS

Release	Modification
Release 6.3.1	Initial Release

This chapter covers the following topics:

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Overview of Hierarchical Modular QoS

Hierarchical QoS (H-QoS) allows you to specify QoS behavior at multiple policy levels, which provides a high degree of granularity in traffic management.

H-QoS is applied on the router interface using nested traffic policies. The first level of traffic policy, the parent traffic policy, is used for controlling the traffic at the main interface or sub-interface level. The second level of traffic policy, the child traffic policy, is used for more control over a specific traffic stream or class. The child traffic policy, is a previously defined traffic policy, that is referenced within the parent traffic policy using the **service-policy** command.

Two-level H-QoS is supported on both ingress and egress directions on all line cards and on physical or bundle main interfaces and sub-interfaces.

Restrictions, Limitations, and Requirements for Configuring H-QoS

There are some key restrictions, limitations, and requirements for configuring H-QoS on your router to ensure optimal performance and compliance.

Parent Traffic Policy Restrictions

- The parent traffic policy only supports the traffic class of type class-default.
- The parent traffic policy only supports the class-action shape, and no other queuing action can be configured in it.
- For congestion avoidance and management, the traffic shaper in the parent traffic policy calculates the queue limit and drop priority

Child Policy Requirements

- While configuring on the router, it is mandatory that the priority class must have a traffic shaper in the child traffic policy.
- The sum of the bandwidth of the child policies must be less than the parent policy's traffic shaper.

H-QoS Profile Limitations

- H-QoS profile and ingress peering profile don't work simultaneously. Hence, features requiring a peering profile also do not work with the H-QoS profile enabled.
- The PBTS feature does not work when the H-QoS profile is enabled. This is due to TCAM limitations.
- A maximum of 896 bundle subinterfaces are supported in the system, even if there are no QoS policies applied. This is due to an internal LAG_ID resource consumption in H-QoS profile mode for bundle subinterfaces with or without QoS policies being applied.
- A maximum of 4 priority levels are supported in H-QoS profile mode, unlike the default mode where 7-priority levels are supported. The restriction also applies to physical and bundle main interface policies where 7-level priorities were previously used in non-H-QoS profile mode.

Bandwidth Configuration Limitations

- Bandwidth and Bandwidth remaining configurations are not supported simultaneously within the same policy-map. If a class has bandwidth (CIR), other classes must also have only bandwidth configuration. If a class-map has bandwidth remaining percent/ratio (EIR), other classes should also have only the bandwidth remaining configuration. Shaping is applied on any class.
- In H-QoS mode, if multiple queues are configured with BRR and there is high congestion in the LP (low-priority) queues, one BRR queue receives more credits than the others. The deviation is proportional to the congestion in the LP queues.
- The granularity of bandwidth or the bandwidth remaining ratio (BRR) is 1:64, compared to 1:4096 in non-H-QoS mode. Consequently, there may be differences in bandwidth performance accuracy depending on the values used.

Priority Classes Requirements

Priority classes must be rate-limited using a shaping configuration. The effective shaper value is used as the priority bandwidth reservation. The total priority bandwidth reservations across all subinterfaces and main interfaces must not exceed the network interface (NIF) port speed to prevent oversubscription of priority traffic. Non-priority class rates and parent shaping can be oversubscribed.

Multicast Traffic Restriction

Filtering egress IPv4 and IPv6 multicast traffic is not supported when H-QoS is configured on the router.

Configuring Hierarchical Queuing

Before you configure H-QoS, you must enable the H-QoS profile on the router. After enabling H-QoS profile, reload the router, as shown in the following configuration.

```
admin
hw-module location all reload
Router# configure
Router(config)# hw-module profile qos hqos-enable
Router(config)# commit
Router# admin
sysadmin-vm:0_RP0# hw-module location all reload
```

The steps that are involved in configuring hierarchical queuing are as follows:

1. Configure a class-map.
2. Configure a child traffic policy using the class-map that was configured in the previous step.
3. Configure a parent traffic policy and add the child traffic policy in it.

The parent traffic policy is the H-QoS traffic policy and it can be applied on physical or bundle main interfaces and sub-interfaces.

Configuration Example

Configuration of a class-map is as follows:

```
Router# configure
Router(config)# class-map match-any tc2
Router(config-cmap)# match traffic-class 1
Router(config-cmap)# end-class-map
Router(config)# commit
```

Configuration of a child traffic policy is as follows:

```
Router# configure
Router(config)# policy-map child
Router(config-pmap)# class tc2
Router(config-pmap-c)# shape average percent 20
Router(config-pmap-c)# exit
Router(config-pmap)# class class-default
Router(config-pmap-c)# shape average percent 1
Router(config-pmap)# end-policy-map
Router(config)# commit
```

Configuration of a parent traffic policy is as follows:

```
Router# configure
Router(config)# policy-map parent
Router(config-pmap)# class class-default
Router(config-pmap-c)# service-policy child
Router(config-pmap-c)# shape average percent 50
```

```
Router(config-pmap)# end-policy-map
Router(config)# commit
```

Running Configuration

```
/* Configuration of a Class-map */
class-map match-any tc2
 match traffic-class 1
 end-class-map
!
/* Configuration of a Child Traffic Policy */
policy-map child
 class tc2
  shape average percent 20
 !
 class class-default
  shape average percent 1
 !
 end-policy-map
!
/* Configuration of a Parent Traffic Policy */
policy-map parent
 class class-default
  service-policy child
  shape average percent 50
 !
 end-policy-map
!
```

Applying the Parent Traffic Policy on a Main Interface

```
Router# configure
Router(config)# Interface TenGigE 0/0/0/10
Router(config-int)# service-policy output parent
Router(config-int)# commit
```

Applying the Parent Traffic Policy on a Sub-interface

```
Router# configure
Router(config)# Interface TenGigE 0/0/0/10.1
Router(config-int)# service-policy output parent
Router(config-int)# commit
```

Verification

Verify if the H-QoS traffic policy is applied correctly on the interface using the commands **show qos interface** *interface-name* **output**. In the following example, the **Level1 Class** gives information about the class-map that is associated with the parent traffic policy and the **Level2 Class** gives information about the class-maps that are associated with the child traffic policy.

```
RP/0/RP0/CPU0:ios#show qos interface ten0/0/0/10 output

NOTE:- Configured values are displayed within parentheses
Interface TenGigE0/0/0/10 ifh 0x1e0  -- output policy
NPU Id:                        0
Total number of classes:       3
Interface Bandwidth:           10000000 kbps
VOQ Base:                      1136
Accounting Type:               Layer1 (Include Layer 1 encapsulation and above)
```

```
------------------------------------------------------------------------------
Level1 Class                                =   class-default
Queue Max. BW.                              =   no max (50 %)
Queue Min. BW.                              =   0 kbps (default)
Inverse Weight / Weight                     =   0 / (BWR not configured)
   Level2 Class                                 =   tc2
   Egressq Queue ID                             =   1138 (LP queue)
   Queue Max. BW.                               =   1020015 kbps (20 %)
   Queue Min. BW.                               =   0 kbps (default)
   Inverse Weight / Weight                      =   1 / (BWR not configured)
   Guaranteed service rate                      =   1000000 kbps
   TailDrop Threshold                           =   1253376 bytes / 10 ms (default)
   WRED not configured for this class
   Level2 Class                                 =   class-default
   Egressq Queue ID                             =   1136 (Default LP queue)
   Queue Max. BW.                               =   50625 kbps (1 %)
   Queue Min. BW.                               =   0 kbps (default)
   Inverse Weight / Weight                      =   1 / (BWR not configured)
   Guaranteed service rate                      =   50000 kbps
   TailDrop Threshold                           =   62720 bytes / 10 ms (default)
   WRED not configured for this class
```

The statistics for the packets that have matched the different traffic classes of the parent and child traffic policies can be viewed using the command **show policy-map interface** *interface-name* **output**. Also, this command also shows the number of packets that are transmitted or dropped when the specified action is applied on the packets that have matched the respective traffic class.

```
Router# show policy-map interface ten0/0/0/10 output

TenGigE0/0/0/10 output: parent
Class class-default
  Classification statistics          (packets/bytes)     (rate - kbps)
    Matched             :          2313578823/296138089344         8494665
    Transmitted         :           232805738/29799134464          854465
    Total Dropped       :          2080773085/266338954880         7640200
  Policy child Class tc2
    Classification statistics          (packets/bytes)     (rate - kbps)
      Matched             :          2313578823/296138089344         8494665
      Transmitted         :           232805738/29799134464          854465
      Total Dropped       :          2080773085/266338954880         7640200
    Queueing statistics
      Queue ID                              : 1138

      Taildropped(packets/bytes)            : 2080773085/266338954880
  Policy child Class class-default
    Classification statistics          (packets/bytes)     (rate - kbps)
      Matched             :                    0/0                   0
      Transmitted         :                    0/0                   0
      Total Dropped       :                    0/0                   0
    Queueing statistics
      Queue ID                              : 1136

      Taildropped(packets/bytes)            : 0/0
```

When using hierarchical policers, there is no independent set of hardware counters to store the parent policer statistics. Instead, parent policer statistics are manipulated in the software to be the sum of all child policers under the same policy-map.

This is shown in the following example where two streams of traffic, with CoS value of 1 and 2 are sent at a speed of 3.5 Gbps each.

```
/*Hierarchical Policy Map Configuration*/
==================================================
```

```
Router# show running-config policy-map Hingress
policy-map Hingress
 class class-default
  service-policy ingress
  police rate 5 gbps peak-rate 9 gbps
  !
 !
 end-policy-map
!
 /*Ingress Policy Map Configuration*/
====================================
Router#show running-config policy-map ingress
policy-map ingress
 class cos1
  set traffic-class 1
  police rate 5 gbps
  !
 !
 class cos2
  set traffic-class 2
  police rate 5 gbps
  !
 !
 class class-default
 !
 end-policy-map
!
 /*Policy Map applied at TenGigE0/0/0/6.100 Interface*/
=======================================================
Router#show policy-map interface tenGigE 0/0/0/6.100 input

TenGigE0/0/0/6.100 input: Hingress

Class class-default
  Classification statistics          (packets/bytes)     (rate - kbps)
    Matched             :           856717937/109659895936         6683676
    Transmitted         :           856717937/109659895936         6683676
    Total Dropped       :                   0/0                    0
  Policing statistics                (packets/bytes)     (rate - kbps)
    Policed(conform)    :           856717937/109659895936         6683674
    Policed(exceed)     :                   0/0                    0
    Policed(violate)    :                   0/0                    0
    Policed and dropped :                   0/0

  Policy ingress Class cos1
    Classification statistics          (packets/bytes)     (rate - kbps)
      Matched             :           437826303/56041766784          3341838
      Transmitted         :           437826303/56041766784          3341838
      Total Dropped       :                   0/0                    0
    Policing statistics                (packets/bytes)     (rate - kbps)
      Policed(conform)    :           437826303/56041766784          3341838
      Policed(exceed)     :                   0/0                    0
      Policed(violate)    :                   0/0                    0
      Policed and dropped :                   0/0
      Policed and dropped(parent policer)  : 0/0

  Policy ingress Class cos2
    Classification statistics          (packets/bytes)     (rate - kbps)
      Matched             :           418891634/53618129152          3341838
      Transmitted         :           418891634/53618129152          3341838
      Total Dropped       :                   0/0                    0
    Policing statistics                (packets/bytes)     (rate - kbps)
      Policed(conform)    :           418891634/53618129152          3341838
      Policed(exceed)     :                   0/0                    0
```

```
      Policed(violate)    :                  0/0                    0
      Policed and dropped :                  0/0
      Policed and dropped(parent policer)  : 0/0

  Policy ingress Class class-default
    Classification statistics          (packets/bytes)     (rate - kbps)
      Matched             :                  0/0                    0
      Transmitted         :                  0/0                    0
      Total Dropped       :                  0/0                    0
Policy Bag Stats time: 0
Policy Bag Stats time: 0
```