Chapter 6

Configuring a QoS Scheduler Hierarchy With Scheduler Profiles

This chapter provides information for configuring the QoS scheduler hierarchy using scheduler profiles on the E-series router.

QoS topics are discussed in the following sections:

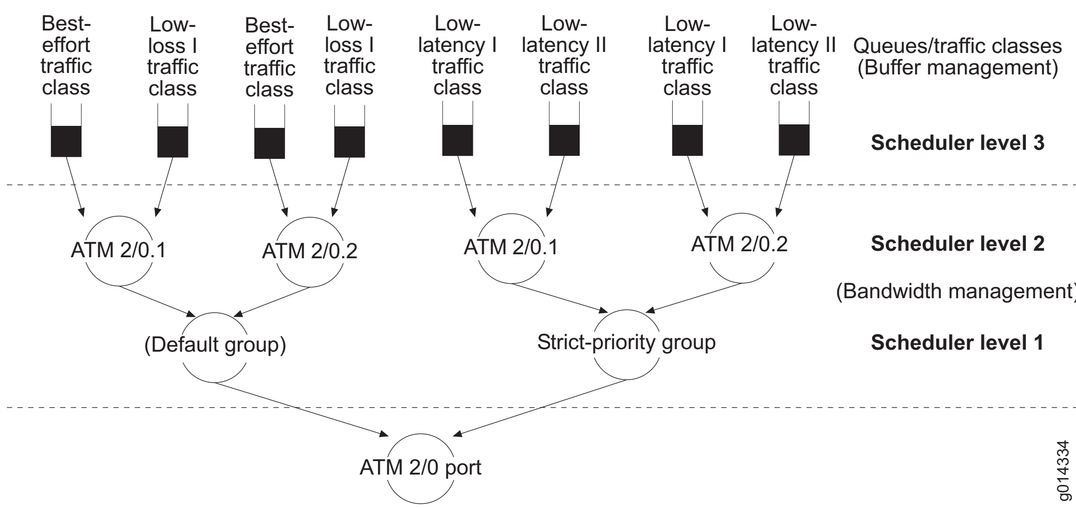
Scheduler Hierarchy Overview

The egress line module scheduler is an HRR scheduler. Figure 8 is an example of a QoS scheduler's hierarchy.

5.2.0b1 ID-1452 (reorganized section and added assured-rate)As shown in Figure 8, the queues feeding a physical port are organized in a hierarchy. At each level in the hierarchy, the scheduler uses shaping rates, hierarchical or assured rates, and relative weights to determine the allocated bandwidth:

- The scheduler selects a first-level node based on the allocated bandwidth.
- The scheduler then selects a second-level node from the group of nodes that are stacked above the selected first-level node. This selection is also based on the allocated bandwidth.
- Finally, the scheduler selects a queue from the group of queues stacked above the second-level node.

Figure 8: QoS Scheduler Hierarchy



Shaping Rates, Assured Rates, and Relative Weights in a Scheduler Hierarchy

The scheduler supports hierarchical and static assured rates, relative weights, and shaping rates on all three levels of the hierarchy: first-level node, second-level node, and queue. The bandwidth delivered from a given node or queue is a function of the shaping rate and either the assured rate or relative weight:

- When the scheduler is not congested, the shaping rates determine which node or queue can claim the bandwidth. The shaping rate specifies the maximum bandwidth to the node or queue.

- When the scheduler is congested, either the hierarchical or static assured rate or the weight specifies the minimum bandwidth.

  - If the scheduler is configured to use a static assured rate and the assured rate is other than none (the default), it is used to determine the allocated bandwidth, and the weight setting is ignored. If the assured rate is zero, the weight setting is used to determine the bandwidth.

    The static assured rate specifies the desired bandwidth. This rate is guaranteed until the bandwidth becomes oversubscribed.

  - If the scheduler is configured to use hierarchical assured rate, the scheduler dynamically adjusts the amount of allocated bandwidth for service delivery based on the sum of the assured rates of all child nodes and queues.

  - The assured rate also specifies that if bandwidth is over- or undersubscribed, all adjustments are made in proportion to the original assured-rate specification.

  For example, if Node A is configured to receive 40 Mbps and Node B receives 20 Mbps, any available bandwidth above the subscribed total of 60 Mbps would be allocated to the two nodes at the same 2-to-1 ratio. Similarly, if the bandwidth were oversubscribed and only 30 Mbps were available, this amount would also be allocated to the two nodes at the 2-to-1 ratio, with Node A getting 20 Mbps and Node B getting 10 Mbps.

NOTE: For E-series ASIC modules, strict priority is supported only for a single first-level scheduler node.

8.1.0FRS per tlemaire (SLB)When determining the shaping rate, the system includes all bytes in Layer 2 encapsulations. The packets that are included in the rate depend on the Layer 2 node that is specified in the QoS profile. For example, the shaping rate for an Ethernet node includes bytes from the Ethernet and VLAN encapsulations.

Related Topics

- Rate Shaping and Port Shaping Overview
- Static and Hierarchical Assured Rate Overview

Scheduler Profile Platform Considerations

7.0.0b2QoS scheduling is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

Interface Specifiers

The configuration task examples in this chapter use the *slot/port* format to specify an interface. However, the interface specifier format that you use depends on the router that you are using.

For ERX-7xx models, ERX-14xx models, and ERX-310 routers, use the *slot/port* format. For example, the following command specifies an ATM interface on slot 0, port 1 of an ERX-7xx model, ERX-14xx model, or ERX-310 router.

host1(config)#**interface atm 0/1**

For E120 and E320 routers, use the *slot/adapter/port* format, which includes an identifier for the bay in which the I/O adapter (IOA) resides. In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router). For example, the following command specifies an ATM interface on slot 5, adapter 0, port 0 of an E320 router.

host1(config)#**interface atm 5/0/0**

For more information about supported interface types and specifiers on E-series routers, see *Interface Types and Specifiers* in *JUNOSe Command Reference Guide, About This Guide*.

Configuring a Scheduler Hierarchy

Overview taskWhen you configure a scheduler hierarchy, you configure the scheduler profile and assign attributes.

To configure a scheduler hierarchy:

1. Configure a scheduler profile.

   See *Configuring a Scheduler Profile for a Scheduler Hierarchy*.

2. Configure attributes in the scheduler profile.

   - (Optional) Configure a shaping rate for rate shaping or port shaping.

     See *Configuring Rate Shaping for a Scheduler Node or Queue* or *Configuring Port Shaping*.

   - (Optional) Configure an assured rate.

     See *Configuring an Assured Rate for a Scheduler Node or Queue*.

   - (Optional) Configure the HRR weight.

     See *Configuring the HRR Weight for a Scheduler Node or Queue.*

   - (Optional) Configure shared shaping.

     See *Chapter 8, Configuring Simple Shared Shaping of Traffic* and ***Chapter 12, Configuring Compound Shared Shaping of Traffic***.

3. Reference the scheduler profile in a QoS profile and apply to an interface.

   See *Chapter 13, Configuring and Attaching QoS Profiles to an Interface Hierarchy*.

Related Topics

- *Chapter 24, Configuring a QoS Parameter*

Configuring a Scheduler Profile for a Scheduler Hierarchy

The router supports up to 1000 scheduler profiles.

To create a scheduler profile for a scheduler hiearchy:

- Create a scheduler profile by assigning a name that represents the type of service and enter Scheduler Profile Configuration mode.

  host1(config)#**scheduler-profile sp-1mbs**
  host1(config-scheduler-profile)#

Related Topics

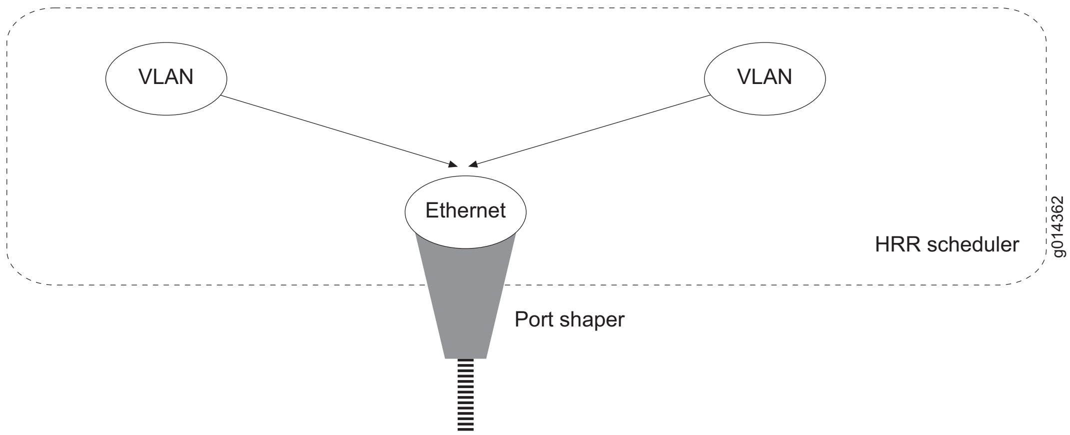
- Rate Shaping and Port Shaping Overview
- Configuring an Assured Rate for a Scheduler Node or Queue
- Configuring the HRR Weight for a Scheduler Node or Queue

Rate Shaping and Port Shaping Overview

Rate shaping throttles the rate at which queues transmit packets. Rate shaping is TCP friendly; that is, it buffers packets that are above the rate, rather than dropping them.

Port shaping enables you to shape the aggregate traffic through a port or channel to a rate that is less than the line or port rate. With port shaping, you can configure scheduler nodes at the port level, as shown in Figure 9.

Figure 9: Port Shaping on an Ethernet Module



The per-port shaping feature provides the ability to shape the output of a port.

Configuring Rate Shaping for a Scheduler Node or Queue

The router supports 64,000 rate shapers per line module. Shaping rates are multiples of 1 Kbps.

To configure a shaping rate for a scheduler node or queue:

1. Configure a scheduler profile.

   host1(config)#**scheduler-profile video**
   host1(config-scheduler-profile)#

2. Specify a shaping rate in the scheduler profile.

   host1(config-scheduler-profile)#**shaping-rate 128000 burst 32767 milliseconds**
   host1(config-scheduler-profile)#**shaping-rate 5000 x 90**

   The range for the shared-shaping rate is 1000–1000000000 bps (1 Kbps–1000 Kbps); the default is the minimum shaping rate (1 Kbps). The router rounds the rate to the next higher 8 Kbps.

   You can use the **bps** or **kbps** keywords to specify the unit of the shaping rate. By default, the shaping rate is configured in bps. 8.0.0b1 RLI-2041 (SLB)

   Use the **burst** keyword to specify the catch-up number associated with the shaper; the range is 0–522240. Specifying 0 enables the router to select an applicable default value.

   Use the **milliseconds** or **bytes** keywords to specify the unit of the burst size. 7.1.0b1 RLI-2145; added here at b2 (SLB)

Related Topics

- Configuring a Scheduler Profile for a Scheduler Hierarchy

- **scheduler-profile** command
- **shaping-rate** command

Configuring Port Shaping

To configure port-shaping:

1. Configure the scheduler profile and the shaping rate.

   host1(config)#**scheduler-profile 80mbps**
   host1(config-scheduler-profile)#**shaping-rate 80000000**
   host1(config-scheduler-profile)#**exit**

2. Configure a QoS profile, specify the **node** command, and reference the scheduler-profile.

   host1(config)#**qos-profile 80mbps**
   host1(config-qos-profile)#**ethernet node scheduler-profile 80mbps**
   host1(config-qos-profile)#**exit**

3. Attach the QoS profile to the port.

   host1(config)#**interface fastethernet 2/0**
   host1(config-if)#**qos-profile 80mbps**

This configuration shapes Fast Ethernet port 2/0 to a rate no higher than 80 Mbps.

In the following configuration, you can shape the corresponding HDLC channel down to 20 Mbps:

host1(config)#**scheduler-profile 20mbps**
host1(config-scheduler-profile)#**shaping-rate 20000000**
host1(config-scheduler-profile)#**exit**
host1(config)#**qos-profile 20mbps**
host1(config-qos-profile)#**serial node scheduler-profile 20mbps**
host1(config-qos-profile)#**exit**
host1(config)#**interface serial 2/0:1/1**
host1(config-if)#**qos-profile 20mbps**

Related Topics

- For more information about specifying an expression that you can reference within a scheduler profile, see *Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy*.
- **node** command
- **qos-profile** command

Static and Hierarchical Assured Rate Overview

You can configure the effective weight of the scheduler node or queue by configuring a static assured rate or a hierarchical assured rate (HAR). The JUNOSe hierarchical assured rate (HAR) feature provides a more powerful and efficient method of configuring assured rates than static assured rates.

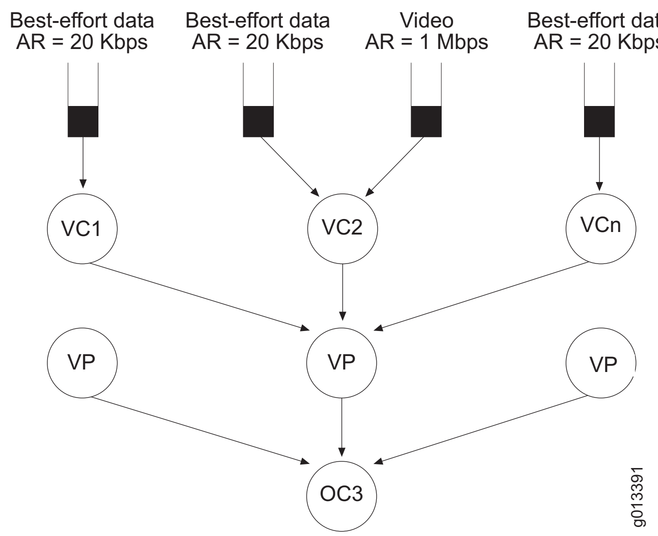
When you use static assured rates, a queue is guaranteed to receive its assured rate only when its parent node is configured with an assured rate that equals the sum of all its child assured rates. Therefore, to ensure that a queue receives its specified assured rate, you must frequently recalculate the assured rates on all parent nodes in the queue's hierarchy. This recalculation is necessary because of the number of scheduler nodes and queues that may be dynamically created or deleted through applications such as bandwidth-on-demand. Eventually, this complicated manual recalculation process becomes unreasonable and virtually impossible.

HAR replaces the manual recalculation process by directing the router to dynamically calculate the assured rate for a scheduler node based on the sum of the assured rates of all its child nodes and queues. For example, you might use HAR to increase the effective weight of an ATM-VC scheduler node when a video queue is created, and to later restore the effective rate of the node when the video queue is deleted.

HAR is applicable only to level 1 and level 2 scheduler nodes, and is not applicable to queues or ports. When you configure HAR, the changes take place immediately. When you disable HAR, the scheduler node's previous weight is restored.

Figure 10 shows an application of HAR for VC nodes. In the example, VCs, which are configured for HAR, are stacked over virtual path (VP) nodes. The VP nodes are in turn stacked over an OC-3 ATM port. Each VC has a best-effort data queue, which currently has an assured rate of 20 Kbps. The VCs share equal portions of their parent VP's bandwidth. However, when the video queue is added to VC2, HAR enables VC2's share of the VP bandwidth to increase in proportion to the 1-Mbps video queue that was created. The bandwidth of sibling VC nodes, which have only a data queue, is decreased in equal proportions.

Figure 10: Hierarchical Assured Rate



Related Topics

- Configuring an Assured Rate for a Scheduler Node or Queue

Configuring an Assured Rate for a Scheduler Node or Queue

MultitaskYou can configure the effective weight of the scheduler node or queue by configuring a static assured rate or a hierarchical assured rate (HAR). HAR dynamically adjusts the available bandwidth for a scheduler node based on the creation and deletion of other scheduler nodes.

By default, the HRR weight is configured for the scheduler profile. If the assured rate setting is other than none (the default), then the assured rate is used instead of the HRR weight setting for the scheduler node or queue.ID-1452 5.2.0b1

Configuring a Static Assured Rate

To configure a static assured rate:

1. Configure a scheduler profile.

   host1(config)#**scheduler-profile static**
   host1(config-scheduler-profile)#

2. Specify a numeric rate with the **assured-rate** command in the scheduler profile.

   host1(config-scheduler-profile)#**assured-rate 56000**

   For a static assured rate, specify the bits per second value in the range 25000–1000000000 bps (25 Kbps to 1 Gbps); the default is none (no assured rate).

Configuring a Hierarchical Assured Rate

To specify that the HAR is used for scheduler nodes (HAR is not used for queues or ports):5.3.0b1 RLI-866

1. Configure a scheduler profile.

   host1(config)#**scheduler-profile har**
   host1(config-scheduler-profile)#

2. Specify the **hierarchical** keyword with the **assured-rate** command in the scheduler profile.

   host1(config-scheduler-profile)#**assured-rate hierarchical**

Configuring an Assured Rate with an Expression

To configure the assured rate using an expression:7.1.0b1 RLI-2145; added here at b2 (SLB)

1. Configure a scheduler profile.

   host1(config)#**scheduler-profile assured-expression**
   host1(config-scheduler-profile)#

2. Specify the *operator* and *operandValue* variables with the **assured-rate** command in the scheduler profile.

   host1(config-scheduler-profile)#**assured-rate 50000 - 31000**

Changing the Assured Rate to an HRR Weight

To change an assured rate to an HRR weight:

1. Specify the scheduler profile.

   host1(config)#**scheduler-profile assured-expression**
   host1(config-scheduler-profile)#

2. Delete the configured assured rate.

   host1(config-scheduler-profile)#**no assured-rate**

   The assured rate in the scheduler profile reverts to using the HRR weight specification.

Related Topics

- For more information about specifying an expression that you can reference within a scheduler profile, see *Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy*.
- Configuring the HRR Weight for a Scheduler Node or Queue
- **assured-rate** command

Configuring the HRR Weight for a Scheduler Node or Queue

You can set the HRR weight of the scheduler node or queue. The weight value is used when no assured rate is set. ID-1452 5.2.0b1

To configure a static weight:

1. Specify the scheduler profile.

   ```
   host1(config)#scheduler-profile relative
   host1(config-scheduler-profile)#
   ```

2. Specify the weight value with the **weight** command in the scheduler profile.

   ```
   host1(config-scheduler-profile)#weight 10
   host1(config-scheduler-profile)#weight 800 - 200
   ```

   The weight value is in the range 0–4080. The default weight is 8. Weight 0 (zero) is a special weight that is used for relative strict-priority scheduling.

Related Topics

- For more information about specifying an expression that you can reference within a scheduler profile, see *Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy*.
- Relative Strict-Priority Scheduling Overview on page 51
- **weight** command

Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy

Expressions are combinations of constants and operators. You can specify some scheduler profile attributes using an expression, such as the shaping rate. All operations within expressions are performed using 64 bit unsigned math, resulting is a 32 bit, signed integer value.

Expressions consist of both operators and operand values. Operators are mathematical functions, and operand values are the inputs for the mathematical function. Operand values can be an integer. You specify an expression consisting of an operand, followed by zero or more [operator, operand] pairs.

You can specify bandwidth as a percentage and burst in milliseconds or bytes by using expressions with the **shaping-rate**, **shared-shaping-rate**, **assured-rate**, and **weight** commands.

When calculating constant shaping rates, use the following formula to translate burst values from bytes to milliseconds (ms):

$$\text{Time (ms)} = \text{Rate (bps)} \times 1000\ \text{(ms/s)} / (\text{burstValueBytes} \times 8\ \text{bits/byte})$$

Using this formula, a 2 Mbps service with a 500 KB burst yields:

$$(2000000 \times 1000)/(50000 \times 8) = 500 \text{ ms}$$

The shaping rate is calculated when the QoS profile is attached based on the parameter instance. For example:

host1(config)# **scheduler-profile sp-1mbs**
(config-scheduler-profile)# **shaping-rate video-bandwidth % 100 burst 500 milliseconds**

When the shaping rate for video-bandwidth is 2 Mbps, the burst value is calculated using the following formula:

$$\text{Burst Value (bits)} = \text{Rate (bps)} \times 1000 \text{ (ms/s)} / \text{Time (ms)}$$

The burst value in bits is calculated as:

$$\text{Burst Value (bits)} = 2000000 \times 1000 / 500 = 4000000$$

The burst value in bytes is calculated as:

$$\text{Burst Value (bytes)} = 4000000 / 8 = 500000$$

Related Topics

- For more information about using expressions within scheduler profiles that are used for QoS parameters, see *Scheduler Profiles and Parameter Expressions for QoS Administrators*.

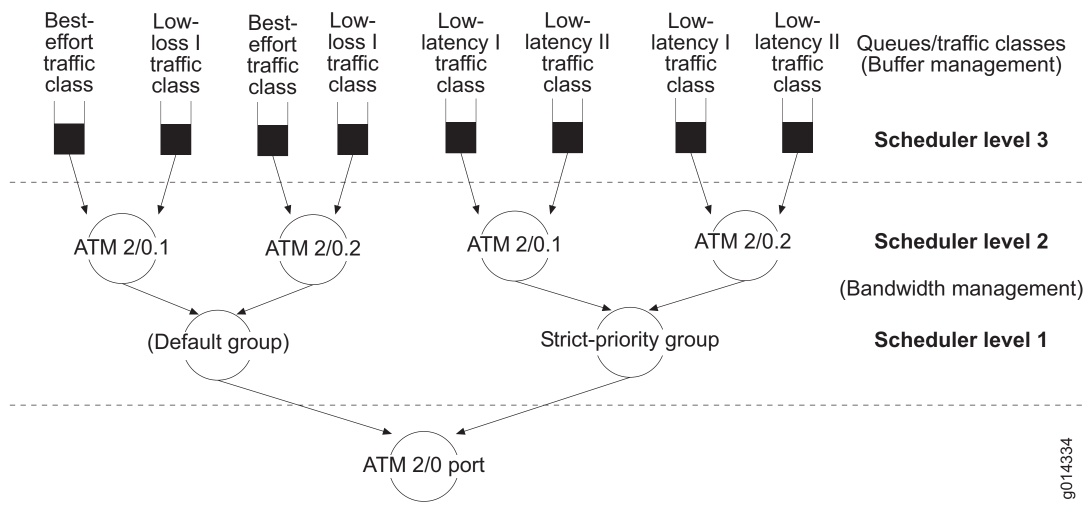
Strict-Priority Scheduling Overview

You can configure one or more strict-priority queues per interface. Strict-priority scheduling is implemented with a special strict-priority scheduler node that is stacked directly above the port. Queues stacked on top of the strict-priority scheduler node always get bandwidth before other queues.

You can configure only one node at the first scheduler level as strict priority. If any node or queue above the strict-priority node has packets, it is scheduled next. If multiple queues above the strict-priority node have packets, the HRR algorithm selects which strict-priority queue is scheduled next.

Figure 11 illustrates an example of a QoS scheduler's hierarchy.

Figure 11: Sample Strict-Priority Scheduling Hierarchy



One strict priority traffic-class group is called the auto-strict-priority group. The scheduler nodes and queues in the auto-strict-priority group receive strict-priority scheduling. If multiple queues above the strict-priority node have packets, the HRR algorithm selects which strict-priority queue is scheduled next.

NOTE: If you configured traffic shaping through traffic shape profiles in JUNOSe releases before Release 4.0, traffic shaping is replaced with the rate-shaping feature, which is configured when you configure a scheduler profile.

Related Topics

- Configuring Strict-Priority Scheduling

Configuring Strict-Priority Scheduling

To configure strict-priority scheduling:

1. Configure a scheduler profile for strict-priority traffic.

```
host1(config)#scheduler-profile strictPriorityBandwidth
host1(config-scheduler-profile)#shaping-rate 20000000
host1(config-scheduler-profile)#exit
```

2. Configure the traffic classes.

```
host1(config)#traffic-class Low-loss-1
host1(config-traffic-class)#exit
host1(config)#traffic-class Low-latency-1
host1(config-traffic-class)#exit
host1(config)#traffic-class Low-latency-2
host1(config-traffic-class)#exit
```

3. Configure the auto-strict-priority traffic-class group, and add the traffic classes that must receive strict-priority scheduling to the group.

   host1(config)#**traffic-class-group Strict-priority auto-strict-priority**
   host1(config-traffic-class-group)#**traffic-class Low-latency-1**
   host1(config-traffic-class-group)#**traffic-class Low-latency-2**
   host1(config-traffic-class-group)#**exit**

4. Configure a QoS profile.

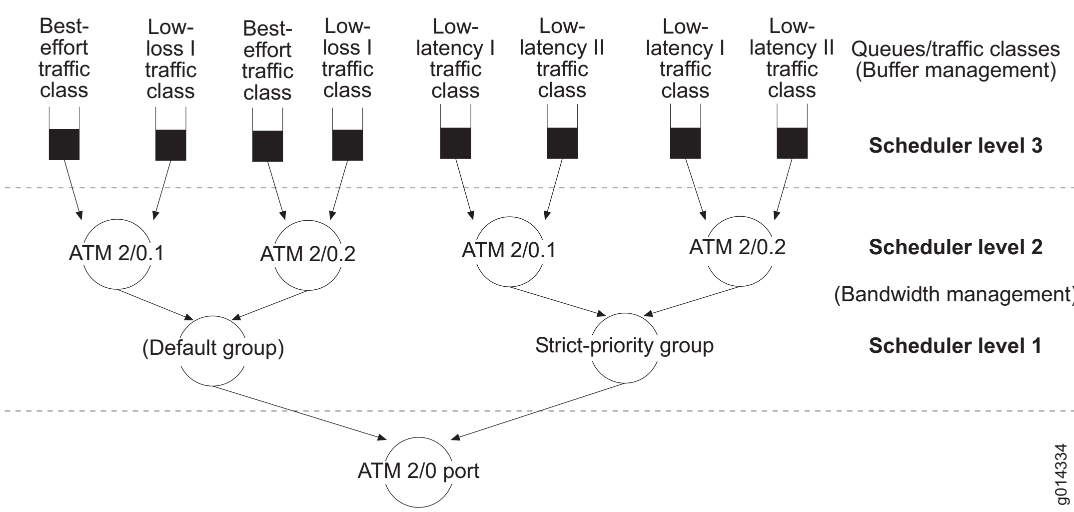
   host1(config)#**qos-profile Example-qos-profile**
   host1(config-qos-profile)#**atm group default**
   host1(config-qos-profile)#**atm group Strict-priority scheduler-profile strictPriorityBandwidth**
   host1(config-qos-profile)#**atm-vc node group default**
   host1(config-qos-profile)#**atm-vc node group Strict-priority**
   host1(config-qos-profile)#**atm-vc queue traffic-class best-effort**
   host1(config-qos-profile)#**atm-vc queue traffic-class Low-loss-1**
   host1(config-qos-profile)#**atm-vc queue traffic-class Low-latency-1**
   host1(config-qos-profile)#**atm-vc queue traffic-class Low-latency-2**
   host1(config-qos-profile)#**exit**

5. Attach the QoS profile to an interface.

   host1(config)#**interface atm 2/0**
   host1(config-if)#**qos-profile Example-qos-profile**
   host1(config-if)#**exit**
   host1(config)#

This configuration creates the hierachy shown in Figure 12.

Figure 12: Sample Strict-Priority Scheduling Hierachy



Related Topics

- For more information about specifying an expression that you can reference within a scheduler profile, see *Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy*.
- **strict-priority** command

Relative Strict-Priority Scheduling Overview

Relative strict-priority scheduling provides strict-priority scheduling within a shaped aggregate rate. For example, it allows you to provide 1 Mbps of aggregate bandwidth to a subscriber, with up to 500 Kbps of the bandwidth for low-latency traffic. If there is no strict-priority traffic, the low-latency traffic can use up to the full aggregate rate of 1 Mbps.

Relative strict priority differs from true strict priority in that it can implement the aggregate shaping rate for both strict and nonstrict traffic. With true strict priority, you can shape the nonstrict or the strict traffic separately, but you cannot shape the aggregate to a single rate.

The best application of relative strict priority is on Ethernet, where you can shape the aggregate for each VLAN to a specified rate, and provision a strict and nonstrict queue for each VLAN above the shaped VLAN node.

To use relative strict priority, you configure strict-priority queues above the VC or VLAN scheduler node, thereby providing for strict-priority scheduling of the queues within the VC or VLAN. You configure relative strict priority without using QoS traffic-class groups, which causes strict-priority queues to appear in the same scheduler hierarchy as the nonstrict queues.

Relative strict priority provides low latency only if you undersubscribe the port by shaping all VCs on the port so that the sum of the shaping rates is less than the port rate. The port will not become congested, and the latency caused by the round-robin behavior of both the HRR and cell schedulers is nominal. In these undersubscribed conditions, the latency of a strict-priority queue within each VC is calculated as if the VC were draining onto a wire with bandwidth equal to the shaped rate.

Relative strict priority is carried out in the HRR scheduler on E-series ASIC line modules.

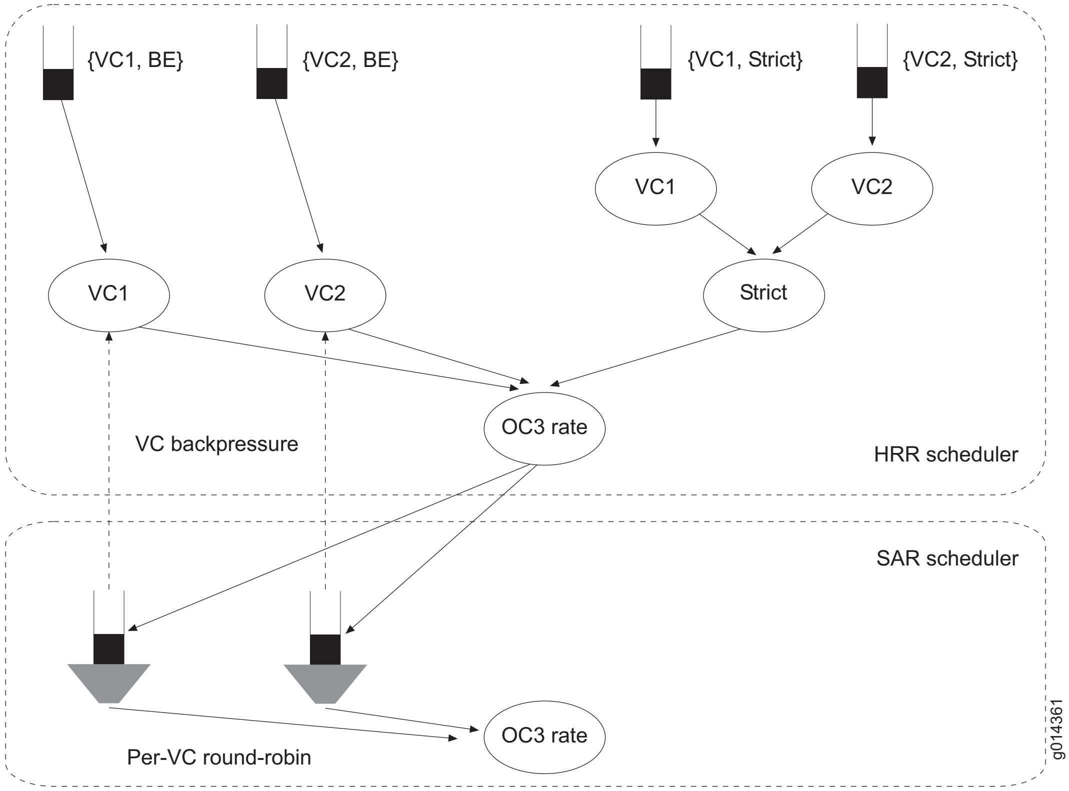
Comparison of True Strict Priority with Relative Strict Priority Scheduling

This section explains how the HRR and SAR schedulers handle true strict-priority and relative strict-priority configurations.

True Strict Priority

In the strict-priority configuration in Figure 13, the queues stacked above the single strict priority scheduler node make up a round-robin separate from the nonstrict queues. All strict queues are drained to completion first, and any residual bandwidth is allocated to the nonstrict round-robin.

Figure 13: True Strict-Priority Configuration



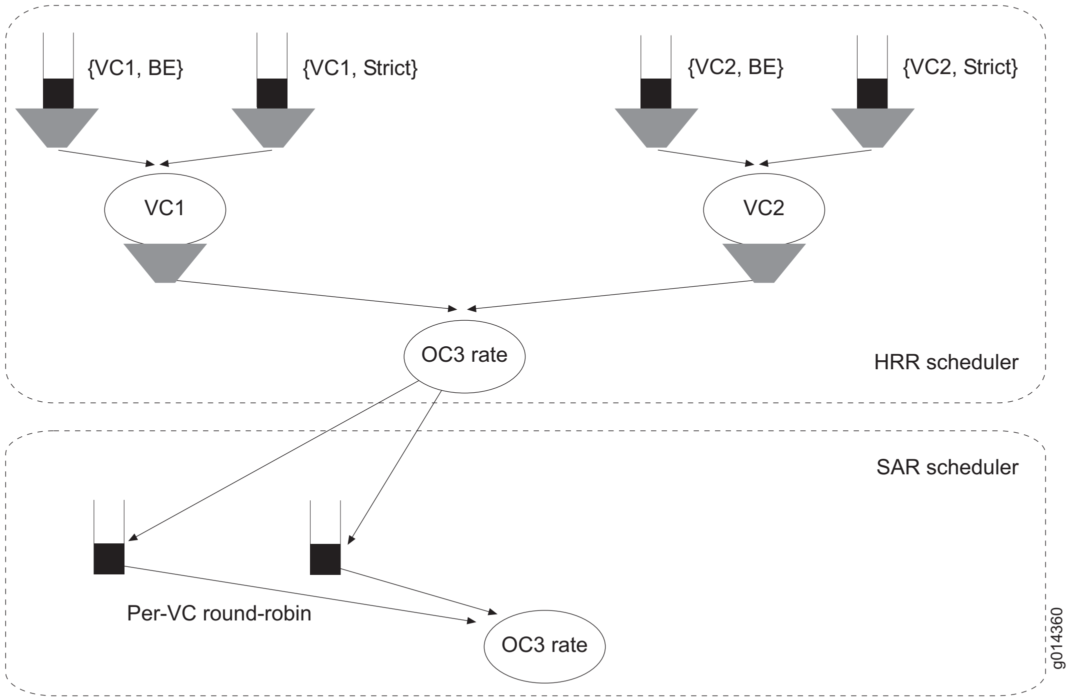
This configuration provides low latency for the strict-priority queues, irrespective of the state of the nonstrict queues. The worst-case latency for a strict packet caused by a nonstrict packet is the propagation delay of a single large packet at the port rate. For a 1500 byte frame at OC3 rate, that latency is less than 100 microseconds.

Because the strict and nonstrict packets for a VC are scheduled in separate round robins, the scheduler cannot enforce an aggregate rate for both of them.

Relative Strict Priority

In the relative strict-priority configuration in Figure 14, the scheduler provides relative strict-priority scheduling relative to the VC. If the port is not oversubscribed, the VC round robin does not cause significant latency.

Figure 14: Relative Strict-Priority Configuration



This configuration provides a latency bound for the relative strict-priority queues. The worst-case latency caused by a nonstrict packet is the propagation delay of a single large packet at the VC rate. For a 1500 byte frame at a 2 Mbps rate, that delay is about 6 milliseconds.

This configuration provides for shaping the aggregate of nonstrict and relative strict packets to a single rate, and it is consistent with the traditional ATM model. It does not scale as well as true strict priority, because the nonstrict and relative strict traffic together must not oversubscribe the port rate.

Relative Strict Priority on ATM Modules

You can use relative strict priority on any type of E-series line module; however, on ATM line modules you have an alternative. On ATM line modules you can configure true strict-priority queues in the HRR scheduler and shape the aggregate for the VC in the SAR scheduler. VC backpressure affects only the nonstrict traffic for the VC. For this type of configuration, you should shape the relative strict traffic for each VC in the HRR scheduler to a rate that is less than the aggregate VC rate. This shaping prevents the VC queue in the SAR scheduler from being congested with strict-priority traffic.

The major difference between relative and true strict priority on ATM line modules is that relative strict priority shapes the aggregate for the VC to a pre–cell tax rate, whereas true strict priority shapes the aggregate for the VC to a post–cell tax rate. For example, shaping the VC to 1 Mbps in the HRR scheduler allows 1 Mbps of frame data, but cell tax adds anywhere from 100 Kbps to 1 Mbps additional bandwidth, depending on packet size. Shaping the VC to 1 Mbps in the SAR scheduler allows just 1 Mbps of cell bytes regardless of packet size.

Oversubscribing ATM Ports

You cannot oversubscribe ATM ports and still achieve low latency with relative strict-priority scheduling. There are several ways to ensure that ports are not oversubscribed. The most common is to use a per-VC scheduler by configuring the HRR scheduler with either ATM VP or VC node shaping (using the **atm-vp node** or **atm-vc node** commands), and setting the sum of the shaping rates less than the port rate. In these scenarios, the cell residency in the SAR scheduler is minimal, and cell scheduling does not interfere with relative strict priority.

Minimizing Latency on the SAR Scheduler

There are two methods you can use to control latency on the SAR scheduler. In the first method, you set the ATM QoS port mode to low-latency mode. In low-latency mode, the HRR scheduler controls scheduling, buffering in the SAR scheduler is limited, and latency caused by the SAR scheduler is minimized.

You can also use the default **no qos-mode-port** mode of SAR operation to minimize the latency induced by the SAR. In this method, you set **qos shaping-mode** cell and shape an OC-3 ATM port to 149 Mbps, or an OC-12 ATM port to 600 Mbps. By throttling the rate at which the HRR scheduler delivers packets to the SAR, you bound SAR buffering and latency. This approach retains the flexibility to configure different ATM QoS in the SAR, including shaped VP tunnels, UBR + PCR, nrtVBR, and CBR services.

To set the SAR mode, use the **qos-mode-port** command. For more information about operational modes on ATM interfaces, see *Chapter 14, Configuring an Integrated Scheduler to Provide QoS for ATM*.

NOTE: Controlling latency is not normally required. If you undersubscribe the port rate in the HRR scheduler, you can obtain latency bounds without modifying the SAR mode of operation.

HRR Scheduler Behavior

The HRR scheduler does not offer native strict-priority scheduling above the first scheduler level in the hardware; however, you can configure very large weights in the round robin in the HRR scheduler to obtain approximate strict-priority scheduling. Note that under conditions of low VC bandwidth and large packet sizes, latency and jitter increase because of the inherent propagation delay of large packets over a small shaping rate. The following sections describe additional configuration steps that will ensure that no more than a single nonstrict packet can precede a strict-priority packet on the VC.

Zero-Weight Queues

To reduce latency and jitter, you can configure the relative strict-priority queue with a weight of 0 (zero), which gives the queue a weight of 4080. When a packet arrives at a zero-weighted queue, the queue remains in the active WRR until it is exhausted, whereas competing queues must leave the active WRR because their weight credits are exhausted. To completely drain the queue, configure the maximum burst size. The zero-weighted queue is eventually alone in the active round robin and is effectively drained at strict priority. updated per GNATS 229099 in 8.2.0b1 (SLB)

To configure more than one relative strict queue or node, simply configure a maximum weight, and the two relative strict queues or nodes will share bandwidth fairly. You can shape the nonstrict queue, as described in the next section, to keep latency bounded.

Also, configure only a few nonstrict nodes or queues to prevent additional latency and jitter of the relative strict-priority traffic when the nodes or queues are in the round robin and a packet arrives in the zero-weighted queue. The number of nonstrict frames that precede a relative strict frame equals the number of nonzero weighted queues among the sibling scheduler nodes.

Nonstrict queues must still exhaust their weight credits before they leave the active round robin. The result is that occasionally more than one nonstrict frame may precede a relative strict frame, causing more jitter than may be acceptable. You can eliminate this source of latency by shaping the nonstrict queue to the aggregate rate with a burst size of 1.

Setting the Burst Size in a Shaping Rate

The burst value in a shaping rate determines the number of rate credits that can accrue when the queue or scheduler node is held in the inactive round robin. When the queue is back on the active list, the accrued credits allow the queue or node to catch up to the configured rate, up to the burst value.

Normally, the burst size is several packet lengths to allow a queue deprived of bandwidth because of congestion to catch up to its rate. Larger burst sizes allow more bursting to allow the queue to attain its shaped rate under bursty congestion scenarios.

Special Shaping Rate for Nonstrict Queues

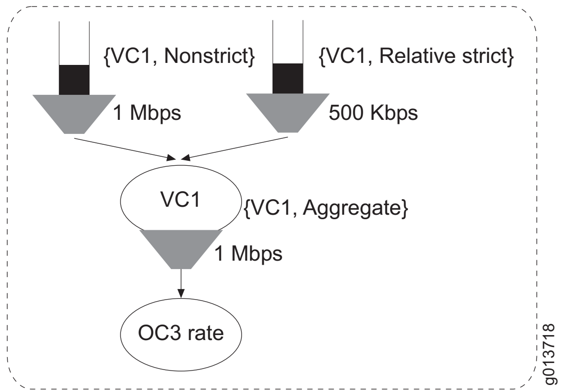
To remove additional jitter, you can configure the nonstrict queue with a special shaping rate that causes the hardware to temporarily eject the queue from the active round robin whenever it sends a frame. The result is that at most one nonstrict frame can precede a relative strict-priority frame. The special shaping rate is the same rate as the aggregate rate, but with a configured burst size of 1.

You can still configure a shaping rate for the zero-weighted queue or node. This is useful for limiting starvation of the nonstrict traffic in the aggregate.

In Figure 15, the VC node is shaped in the HRR scheduler to 1 Mbps to limit the aggregate traffic for the subscriber. The relative strict traffic is shaped to 500 Kbps. This shaping limits relative strict traffic to 500 Kbps, and prevents the relative strict-priority traffic from starving out the nonstrict traffic.

The third shaper, on the nonstrict queue, is subtle. The rate is 1 Mbps, which allows the nonstrict traffic to consume up to the full aggregate rate of the VC. But the burst size is 1, which causes the nonstrict queue to always yield to the relative strict-priority queue after sending a packet. This burst size limits the number of nonstrict packets that can precede a relative strict-priority packet to the minimum, one packet.

Figure 15: Tuning Latency on Strict-Priority Queues



Configuring Relative Strict-Priority Scheduling for Aggregate Shaping Rates

To configure relative strict priority scheduling for aggregate shaping rates:

1. Create a scheduler profile for the strict-priority queue.

   host1(config)#**scheduler-profile relativeStrict**
   host1(config-scheduler-profile)#**shaping-rate 500000**
   host1(config-scheduler-profile)#**weight 0**
   host1(config-scheduler-profile)#**exit**

   Configuring the weight of 0 reduces latency and jitter.

2. Create a scheduler profile for the nonstrict best-effort queue.

   host1(config)#**scheduler-profile be**
   host1(config-scheduler-profile)#**shaping-rate 1000000 burst 1**
   host1(config-scheduler-profile)#**weight 8**
   host1(config-scheduler-profile)#**exit**

TIP: If you need to impose a shaping rate on the nonstrict queues to meet a functional requirement, you can specify a rate less than the aggregate rate. The key is that the burst size must be one, or small. The burst size determines the maximum-sized packet that can squeeze in front of a relative strict-priority packet in the round robin.

3. Create a scheduler profile for the aggregate bandwidth.

   host1(config)#scheduler-profile vcAggregate
   host1(config-scheduler-profile)#shaping-rate 1000000
   host1(config-scheduler-profile)#exit

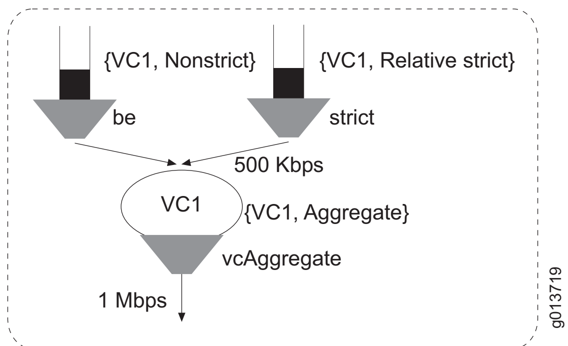
4. Create a QoS profile, configure node shaping for each queue, and add each of the queues to the QoS profile.

   host1(config)#**qos-profile relative-strict-aggregate**
   host1(config-qos-profile)#**atm-vc node scheduler-profile vcAggregate**

```
host1(config-qos-profile)#atm-vc queue traffic-class best-effort
scheduler-profile be
host1(config-qos-profile)#atm-vc queue traffic-class voice scheduler-profile
relativeStrict
host1(config-qos-profile)#exit
host1(config)#
```

This configuration creates the hierarchy shown in Figure 16.

Figure 16: Sample Relative Strict-Priority Scheduler Hierarchy



Related Topics

- Relative Strict-Priority Scheduling Overview
- For more information about specifying an expression that you can reference within a scheduler profile, see *Using Expressions for Bandwidth and Burst Values in the Scheduler Hierarchy*.
- **node** command
- **qos-profile** command
- **scheduler-profile** command
- **shaping-rate** command
- **weight** command

Monitoring QoS Scheduling

To monitor QoS scheduling:

- Monitoring the QoS Scheduler Hierarchy on page 313
- Monitoring the Configuration of Scheduler Profiles on page 317
- Monitoring Shared Shapers on page 318
- Monitoring Shared Shaper Algorithm Variables on page 319