

Chapter 6

QoS Scheduler Hierarchy Overview

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:

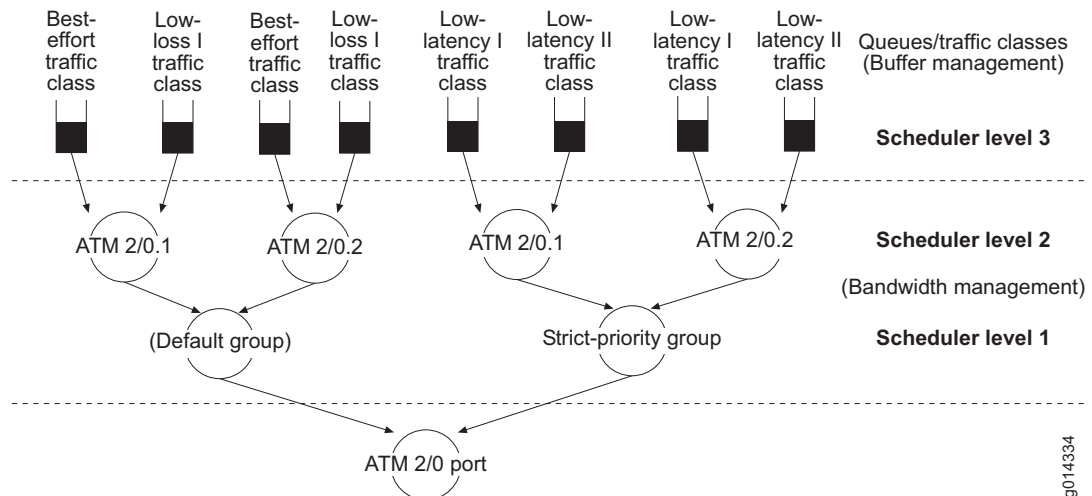
- Scheduler Hierarchy Overview on page 47
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- Configuring a Scheduler Profile for a Scheduler Node or Queue on page 50
- Using Expressions for Bandwidth and Burst Values in a Scheduler Profile on page 51

Scheduler Hierarchy Overview

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

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.

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

- Static and Hierarchical Assured Rate Overview on page 56
- Rate Shaping and Port Shaping Overview on page 53
- Shared Shaping Overview on page 73
- Configuring a Scheduler Hierarchy on page 49

Configuring a Scheduler Hierarchy

When 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 Node or Queue* on page 50.

2. (Optional) Configure attributes in the scheduler profile.

- Configure a shaping rate for rate shaping or port shaping.

See *Configuring Rate Shaping for a Scheduler Node or Queue* on page 54 or *Configuring Port Shaping* on page 55.

- Configure an assured rate.

See *Configuring an Assured Rate for a Scheduler Node or Queue* on page 57.

- Configure the HRR weight.

See *Configuring the HRR Weight for a Scheduler Node or Queue* on page 59.

- Configure shared shaping.

See *Configuring Simple Shared Shaping* on page 84 and *Configuring Compound Shared Shaping* on page 104.

- Configure implicit and explicit constituent selection.

See *Configuring Implicit Constituents for Simple or Compound Shared Shaping* on page 121 and *Configuring Explicit Constituents for Simple or Compound Shared Shaping* on page 126.

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

See *Configuring a QoS Profile* on page 138 and *Attaching a QoS Profile to an Interface* on page 140.

Related Topics

- Scheduler Hierarchy Overview on page 47
- For information about configuring a scheduling hierarchy with QoS parameters, see *Chapter 24, Configuring a QoS Parameter*

Configuring a Scheduler Profile for a Scheduler Node or Queue

To create a scheduler profile for a scheduler hierarchy:

- 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)#
```

The router supports up to 1000 scheduler profiles.

Related Topics

- Configuring Rate Shaping for a Scheduler Node or Queue on page 54
- Configuring Port Shaping on page 55
- Configuring an Assured Rate for a Scheduler Node or Queue on page 57
- Configuring the HRR Weight for a Scheduler Node or Queue on page 59
- Configuring Simple Shared Shaping on page 84
- Configuring Compound Shared Shaping on page 104

Using Expressions for Bandwidth and Burst Values in a Scheduler Profile

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 in 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* on page 231
- Configuring Rate Shaping for a Scheduler Node or Queue on page 54
- Configuring Port Shaping on page 55
- Configuring an Assured Rate for a Scheduler Node or Queue on page 57
- Configuring the HRR Weight for a Scheduler Node or Queue on page 59
- Configuring Simple Shared Shaping on page 84
- Configuring Compound Shared Shaping on page 104