

Chapter 16

Configuring and Attaching QoS Profiles to an Interface

This chapter provides information for configuring and attaching QoS profiles to an interface.

QoS topics are discussed in the following sections:

- Supported Interface Types for QoS Profiles on page 135
- Configuring a QoS Profile on page 136
- Attaching a QoS Profile to an Interface on page 138
- Munged QoS Profile Overview on page 140
- Example: Port-Type QoS Profile Attachment on page 143
- Example: QoS Profile Attachment to Port on page 145
- Example: Diffserv Configuration with Multiple Traffic-Class Groups on page 147

Supported Interface Types for QoS Profiles

Each QoS profile command begins with a keyword that designates an interface type.

Table 14 lists the interface types and the commands that you can use with them.

Table 14: Interface Types and Supported Commands

Interface Type	Queue	Node	Group	Shadow Node
atm	a	a	a	a
atm-vc	a	a	–	a
atm-vp	a	a	–	a
bridge	a	a	–	a
ethernet	a	a	a	a
fr-vc	a	a	–	a

Table 14: Interface Types and Supported Commands (continued)

Interface Type	Queue	Node	Group	Shadow Node
ip	a	a	–	a
ip-tunnel	a	a	–	a
ipv6	a	a	–	a
l2tp-session	a	a	–	a
l2tp-tunnel	a	a	–	a
lsp	a	a	–	a
serial	a	a	a	a
server-port	a	a	a	a
svlan	a	a	–	a
vlan	a	a	–	a

Related Topics

- Supported Interface Types for QoS Profiles on page 135
- Configuring a QoS Profile on page 136
- Configuring Shadow Nodes on page 156

Configuring a QoS Profile

Before you configure a QoS profile:

- Configure the traffic classes.
See *Configuring Traffic Classes That Define Service Levels* on page 15.
- Configure the queuing hierarchy.
See *Configuring Queue Profiles to Manage Buffers and Thresholds* on page 22.
- Configure the scheduler hierarchy and shaping with scheduler profiles.
See *Configuring a Scheduler Hierarchy* on page 47.

To configure a QoS profile:

1. Create a QoS profile and enter QoS Profile Configuration mode.

```
host1(config)#qos-profile qos-profile
host1(config-qos-profile)#
```

2. (Optional) Configure a group node for each interface.

```
host1(config-qos-profile)#atm group groupA scheduler-profile scheduler1
statistics-profile statpro-1
```

When you configure a group node, you can also reference a default or named traffic-class group, a scheduler profile, or a statistics profile.

If you do not specify a traffic-class group, the group node defaults to the *default* group. Each traffic class can belong to only one traffic-class group (either the default group or a named group).

The router supports up to four traffic-class groups above a given port.

3. (Optional) Configure a scheduler node for interfaces.

```
host1(config-qos-profile)#atm node scheduler-profile scheduler1 group strict-priority
```

When you configure a scheduler node, you can also reference a default or named traffic-class group and a scheduler profile.

The scheduler profile supplies a relative weight and potentially a shaping rate to be applied at the scheduler node.



NOTE: You cannot associate a scheduler profile with a port-type interface unless you also specify the strict-priority group.

4. (Optional) Configure a queue for interfaces in the specified traffic class.

```
host1(config-qos-profile)#atm queue traffic-class strict-priority scheduler-profile scheduler1 queue-profile queue1 drop-profile drop1
```

When you configure a queue, you can include any of the following profiles:

- The scheduler profile supplies a relative weight and potentially a shaping rate to be applied at the queue.
- The queue profile supplies threshold information for the queue if the router defaults are not appropriate.
- The drop profile supplies dropping behavior of a set of egress queues.

Each queue traffic class can appear in only one traffic-class group.

Related Topics

- Attaching a QoS Profile to an Interface on page 138
- Supported Interface Types for QoS Profiles on page 135
- Configuring Shadow Nodes on page 156
- Monitoring a Scheduler Hierarchy on an Interface with QoS Profiles on page 161

- For information about configuring QoS profiles with Service Manager, see *JUNOS Broadband Access Configuration Guide, Chapter 27, Configuring Service Manager*
- **group** command
- **node** command
- **qos-profile** command
- **queue** command

Attaching a QoS Profile to an Interface

You can attach a QoS profile to the base of an interface hierarchy, to a specific ATM VP or S-VLAN, or to a port type.

Tasks to attach a QoS profile include:

- Attaching a QoS Profile to a Base Interface on page 138
- Attaching a QoS Profile to an ATM VP on page 138
- Attaching a QoS Profile to an S-VLAN on page 139
- Attaching a QoS Profile to a Port Type on page 139

Attaching a QoS Profile to a Base Interface

You can attach a QoS profile to an interface at the base of an interface hierarchy. Interface types below the attachment point cannot be referenced in the QoS profile.

To attach a profile to an interface:

1. Enter Interface Configuration mode for the interface.

```
host1(config)#interface gigabitEthernet 2/0
```

2. Attach a QoS profile to the interface.

```
host1(config-if)#qos-profile qosp-ethernet-queuing
```

Attaching a QoS Profile to an ATM VP

You can associate a QoS profile with all the ports of a certain interface type.

You can attach a QoS profile to an ATM VP. The profile applies to all VCs in the VP; for example, the profile specifies the scheduler hierarchy of scheduler nodes and queues for all VCs, IP interfaces, and L2TP sessions stacked above the VP.

To attach a profile to an ATM VP:

1. Enter Interface Configuration mode for the interface.

```
host1(config)#interface atm 1.0/1
```

2. Attach a QoS profile to the ATM VP.

```
host1(config-if)#atm-vp 50 qos-profile qosp-vp-strictbw
```

Attaching a QoS Profile to an S-VLAN

You can attach a QoS profile to the specified S-VLAN ID assigned to a VLAN subinterface that is configured over an Ethernet interface. The profile applies to all S-VLANs and VLANs in the interface stack; for example, the profile specifies the hierarchy of scheduler nodes and queues for all VLANs, IP interfaces stacked above the S-VLAN. However, you do not have to configure VLAN subinterfaces over the S-VLAN before you attach the QoS profile to the S-VLAN.

1. Specify the Ethernet interface and create the VLAN.

```
host1(config)#interface gigabitEthernet 3/0  
host1(config-if)#encapsulation vlan  
host1(config-if)#interface gigabitEthernet 3/0.1
```

2. Specify the S-VLAN ID.

```
host1(config-if)#svlan id 0 1
```

3. Attach the QoS profile to the S-VLAN.

```
host1(config-if)#svlan 1 qos-profile qosp-svlan-strictbw
```

Attaching a QoS Profile to a Port Type

By default, the router attaches a QoS port-type profile to all ATM, Ethernet, serial, or server ports. The port-type profile supplies QoS information for all forwarding interfaces stacked above all ports of the associated interface type.

Instead of using the default port-type profile, you can explicitly attach a QoS profile to a port. The QoS profile overrides the default QoS port-type profile. The QoS profile associates queue profiles, drop profiles, statistics profiles, and scheduler profiles with interface types, and it applies to all interfaces stacked above ports of the associated type.

To attach a QoS profile to a port type:

- Issue the **qos-port-type-profile** command from Global Configuration mode:

```
host1(config)#qos-port-type-profile atm qos-profile strict-priority
```

The interface type can be: atm, ethernet, lag, serial, or server-port.

A profile attached to a port must specify a queue for each forwarding interface type in the best-effort traffic class.

To restore the default port-type:

- Issue the **qos-port-type-profile** command and specify the server-default QoS profile from Global Configuration mode:

```
host1(config)#qos-port-type-profile server-port qos-profile server-default
```

Related Topics

- Supported Interface Types for QoS Profiles on page 135
- Configuring a QoS Profile on page 136
- For information about attaching a QoS profile using Service Manager, see *JUNOS Broadband Access Configuration Guide, Chapter 27, Configuring Service Manager*
- **atm-vp qos-profile** command
- **interface** command
- **qos-port-type-profile** command
- **qos-profile** command
- **svlan qos-profile** command

Munged QoS Profile Overview

QoS profile attachments affect the queuing configuration of all the forwarding interfaces stacked above the attachment point. The subtree of the interface hierarchy stacked above the attachment point is the scope of the attachment. When multiple QoS profiles are attached beneath a forwarding interface, the forwarding interface lies in the scope of all the QoS profiles. Rules from all the QoS profiles are combined in a process called *mungeing*. The set of rules used for a given forwarding interface is called the *munged* QoS profile.

When a QoS profile is attached to an interface, the router searches the interface stack, from the point of attachment down to the port interface at the base of the interface hierarchy, to find all QoS profiles attached under that interface. The rules are combined to form the munged QoS profile. The router reconfigures queues for all forwarding interfaces in the scope of the attachment to conform to the munged profile.

The munge algorithm works as follows:

1. Start with the rules in the QoS profile being attached.
2. Traverse down the stack of interfaces until another QoS profile attachment is found.

3. Add rules from the lower-attached QoS profile to the munged QoS profile. Conflicting rules from the lower-attached QoS profile are not added: rules in higher-attached QoS profiles override or eclipse rules in lower-attached QoS profiles.
4. Repeat Steps 2 and 3 until a port interface is reached at the bottom of the interface stack.
 - a. If there is a QoS profile attached at the port, add the profile's rules to the munged QoS profile, and the munge algorithm is then complete.
 - b. If there is no QoS profile attached at the port, then locate the QoS profile indicated in the **qos-port-type-profile** command that corresponds to the interface type of the port. For example, if the port is an ATM interface, the default QoS port-type profile for type ATM is named atm-default. Add the rules in the QoS port-type profile to the munged QoS profile.

The entries in the QoS profile specified in the corresponding **qos-port-type-profile** command have the lowest precedence.

After the munged QoS profile is complete, the router reprocesses the queues for all forwarding interfaces in the scope of the attachment, adding, deleting, or modifying the scheduler hierarchy as required by the munged QoS profile rules.

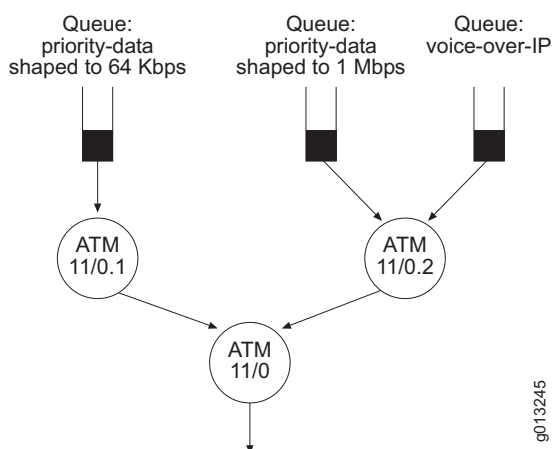
In Step 3, the router must decide which rules from a QoS profile conflict with rules already contained within the munged QoS profile. *Queue* rules are identified by their {interface type, traffic class} pair; two queue rules with the same interface type and traffic class are deemed conflicting. *Node* rules are identified by their {interface type, traffic-class group} pair; two node rules with the same interface type and traffic-class *group* are deemed conflicting.



NOTE: The munge algorithm is modified when you configure QoS for 802.3ad link aggregation interfaces.

Sample Munged QoS Profile Process

Figure 36 shows the relationship between a port-attached QoS profile and a QoS profile that is attached to the specific interface, ATM 11/0.2.

Figure 36: Munged Profile Example

The port-attached QoS profile on ATM 11.0 contains the following queue rule:

```
host1(config)#qos-profile atmPort
host1(config-qos-profile)#ip queue traffic-class priority-data scheduler-profile
64kbps
host1(config-qos-profile)#exit
```

All forwarding interfaces stacked above the port are within the scope of the attachment, so all IP interfaces stacked above the port will be provisioned with a queue in the priority-data traffic class, shaped to 64 Kbps.

The QoS profile attached at subinterface ATM 11/0.2 contains the following two rules:

```
host1(config)#qos-profile atmVc
host1(config-qos-profile)#ip queue traffic-class priority-data scheduler-profile
1mbps
host1(config-qos-profile)#ip queue traffic-class voice-over-ip
host1(config-qos-profile)#exit
```

The queue rule for {interface type IP, traffic-class priority-data} in the QoS profile that is attached to ATM 11/0.2 effectively overrides the queue rule for the same interface type and traffic class in the port-attached QoS profile on ATM11.0.

The second queue rule, which is for the voice-over-ip traffic-class, is not conflicting. In this configuration, the provider has configured a 64 Kbps priority-data queue for each IP interface stacked above the port. But the IP interface above the ATM 11/0.2 attachment provides 1 Mbps for priority-data, and also has a second queue provisioned for VoIP.



NOTE: When a QoS profile is attached to an interface, the router first searches to determine if a munged QoS profile already exists. If you modify an existing QoS profile, the router automatically updates all munged QoS profiles that are dependent on the modified profile.

Related Topics

- For more information about the munge algorithm and 802.3ad link aggregation interfaces, see *Munged QoS Profiles and Load Balancing* on page 194

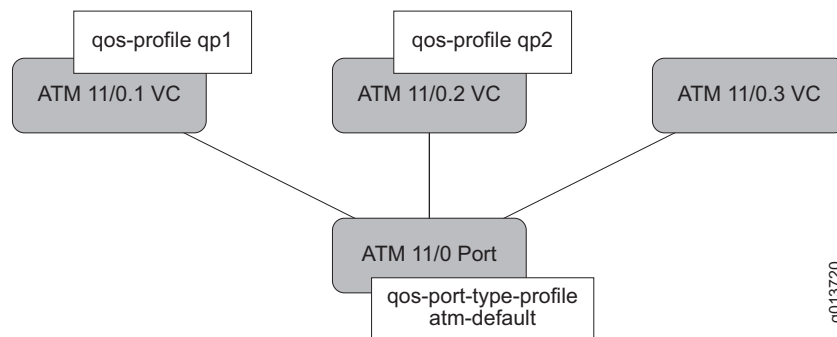
Example: Port-Type QoS Profile Attachment

In this example, three ATM subinterfaces are configured on an ATM port:

- ATM 11/0.1—QoS profile qp1 is attached
- ATM 11/0.2—QoS profile qp2 is attached
- ATM 11/0.3—No QoS profile is attached

The major ATM interface, 11/0, does not have a QoS profile explicitly attached. Therefore, by default the atm-default QoS port-type profile is attached.

Figure 37: Attaching QoS Profiles to ATM Subinterfaces



To configure this example:

1. Create and configure QoS profile qp1.

```
host1(config)#qos-profile qp-1
host1(config-qos-profile)#atm-vp node scheduler-profile sp1
host1(config-qos-profile)#atm-vc queue traffic-class tc1 scheduler-profile sp1
queue-profile qp1
host1(config-qos-profile)#atm-vc queue traffic-class tc2 scheduler-profile sp2
queue-profile qp2
host1(config-qos-profile)#atm-vc queue traffic-class tc3 scheduler-profile sp3
queue-profile qp3
host1(config-qos-profile)#atm-vc queue traffic-class tc4 scheduler-profile sp4
queue-profile qp4
host1(config-qos-profile)#atm-vc queue traffic-class tc5 scheduler-profile sp5
queue-profile qp5
host1(config-qos-profile)#exit
```

2. Create and configure QoS profile qp2.

```
host1(config)#qos-profile qp2
host1(config-qos-profile)#atm-vp node scheduler-profile sp1
```

```

host1(config-qos-profile)#atm-vc queue traffic-class tc1 scheduler-profile sp1
queue-profile qp1
host1(config-qos-profile)#atm-vc queue traffic-class tc2 scheduler-profile sp2
queue-profile qp2
host1(config-qos-profile)#atm-vc queue traffic-class tc3 scheduler-profile sp3
queue-profile qp3
host1(config-qos-profile)#exit

```

3. Attach the QoS profiles to the ATM subinterfaces, as shown in Figure 37.

```

host1(config)#interface atm 11/0.1
host1(config-subif)#qos-profile qp1
host1(config-subif)#exit
host1(config)#interface atm 11/0.2
host1(config-subif)#qos-profile qp2
host1(config-subif)#exit

```

4. Display the QoS interface hierarchy for ATM interface 11/0. This display shows all QoS attachments above interface 11/0.

If no QoS profiles are attached above the specified interface, the router shows the first attachment below the specified interface.

```
host1#show qos interface-hierarchy interface atm 11/0
```

```
attachment@ atm-vc ATM11/0.2:
```

qos profile	interface type	rule type	traffic class	scheduler profile	queue profile	t-class group
qp2@ATM11/0.2	atm-vc	node		sp1	default	
qp2@ATM11/0.2	atm-vc	queue	tc1	sp1	qp1	
qp2@ATM11/0.2	atm-vc	queue	tc2	sp2	qp2	
qp2@ATM11/0.2	atm-vc	queue	tc3	sp3	qp3	
atm-default @atm ip		node		default	default	
atm-default @atm atm-vc		node		default	default	
atm-default @atm Bridge		node		default	default	
atm-default @atm ipv6		node		default	default	
atm-default @atm ip		queue	best-effort	default	default	
atm-default @atm atm		queue	best-effort	default	default	
atm-default @atm atm-vc		queue	best-effort	default	default	
atm-default @atm Bridge		queue	best-effort	default	default	
atm-default @atm ipv6		queue	best-effort	default	default	

```
attachment@ atm-vc ATM11/0.1:
```

qos profile	interface type	rule type	traffic class	scheduler profile	queue profile	t-class group
qp1@ATM11/0.1	atm-vc	node		sp1	default	
qp1@ATM11/0.1	atm-vc	queue	tc1	sp1	qp1	
qp1@ATM11/0.1	atm-vc	queue	tc2	sp2	qp2	
qp1@ATM11/0.1	atm-vc	queue	tc3	sp3	qp3	
qp1@ATM11/0.1	atm-vc	queue	tc4	sp4	qp4	
qp1@ATM11/0.1	atm-vc	queue	tc5	sp5	qp5	
atm-default @atm ip		node		default	default	
atm-default @atm atm-vc		node		default	default	
atm-default @atm Bridge		node		default	default	
atm-default @atm ipv6		node		default	default	

```

atm-default @atm ip          queue best-effort default default
atm-default @atm atm         queue best-effort default default
atm-default @atm atm-vc      queue best-effort default default
atm-default @atm Bridge      queue best-effort default default
atm-default @atm ipv6        queue best-effort default default

```

ATM subinterface 11/0.3 was not shown because no QoS profile is attached to it. You can display the QoS interface hierarchy for subinterface 11/0.3 by specifying the subinterface, as shown below. In this case, the QoS port-type profile, atm-default, is attached (by default) to the ATM major interface, ATM 11/0, below ATM subinterface 11/0.3. Because no QoS profile is attached to this ATM subinterface, the QoS port-type profile is applied.

The @atm in the qos profile column indicates that the row comes from a default QoS port-type profile that is below the interfaces shown: subinterfaces ATM 11/0.2 and ATM 11/0.1 in this example.

You can explicitly show the ATM subinterface that has no explicit QoS profile attachment, as shown below. In this case, attachment@ indicates the ATM major interface (11/0) below the subinterface.

```

host1#show qos interface-hierarchy interface atm 11/0.3
attachment@ atm ATM11/0:
  qos      interface  rule  traffic  scheduler  queue  t-class
profile    type      type  class   profile    profile group
-----
atm-default@atm ip          node                default  default
atm-default@atm atm-vc      node                default  default
atm-default@atm Bridge      node                default  default
atm-default@atm ipv6        node                default  default
atm-default@atm ip          queue best-effort    default  default
atm-default@atm atm         queue best-effort    default  default
atm-default@atm atm-vc      queue best-effort    default  default
atm-default@atm Bridge      queue best-effort    default  default
atm-default@atm ipv6        queue best-effort    default  default

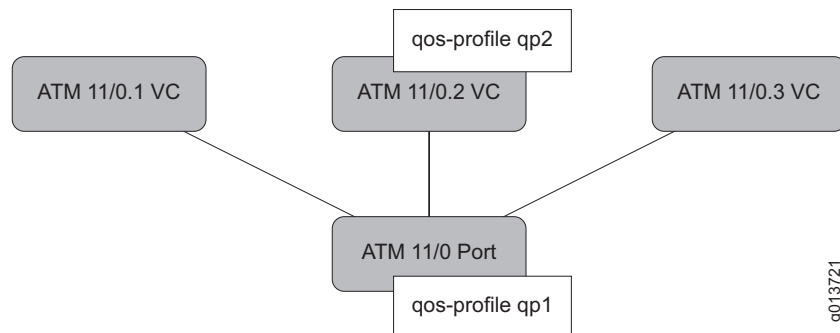
```

Example: QoS Profile Attachment to Port

In Figure 38, the major ATM interface, 11/0, has QoS profile qp1 explicitly attached. The major ATM interface has three ATM subinterfaces configured:

- ATM 11/0.1—No QoS profile is explicitly attached
- ATM 11/0.2—QoS profile qp2 is attached
- ATM 11/0.3—No QoS profile is explicitly attached

The qp1 profile overrides the QoS port-type profile, atm-default, on subinterfaces 1 and 3. It does not override profile qp2, which was explicitly attached to subinterface 2.

Figure 38: Attaching QoS Profile to ATM Interface and Subinterface

To configure this example:

1. Create and configure QoS profile qp1.

```
host1(config)#qos-profile qp-1
host1(config-qos-profile)#atm-vp node scheduler-profile sp1
host1(config-qos-profile)#atm-vc queue traffic-class tc1 scheduler-profile sp1
queue-profile qp1
host1(config-qos-profile)#atm-vc queue traffic-class tc2 scheduler-profile sp2
queue-profile qp2
host1(config-qos-profile)#atm-vc queue traffic-class tc3 scheduler-profile sp3
queue-profile qp3
host1(config-qos-profile)#atm-vc queue traffic-class tc4 scheduler-profile sp4
queue-profile qp4
host1(config-qos-profile)#atm-vc queue traffic-class tc5 scheduler-profile sp5
queue-profile qp5
host1(config-qos-profile)#exit
```

2. Create and configure QoS profile qp2.

```
host1(config)#qos-profile qp2
host1(config-qos-profile)#atm-vp node scheduler-profile sp1
host1(config-qos-profile)#atm-vc queue traffic-class tc1 scheduler-profile sp1
queue-profile qp1
host1(config-qos-profile)#atm-vc queue traffic-class tc2 scheduler-profile sp2
queue-profile qp2
host1(config-qos-profile)#atm-vc queue traffic-class tc3 scheduler-profile sp3
queue-profile qp3
host1(config-qos-profile)#exit
```

3. Attach QoS profile qp1 to ATM interface 11/0.

```
host1(config)#interface atm 11/0
host1(config-if)#qos-profile qp1
host1(config-if)#exit
```

4. Attach QoS profile qp2 to ATM subinterface 11/0.2.

```
host1(config)#interface atm 11/0.2
host1(config-subif)#qos-profile qp2
host1(config-subif)#exit
host1(config)#exit
```

5. Display the QoS interface hierarchy for ATM 11/0.

```

host1#show qos interface-hierarchy interface atm 11/0
qos      interface rule traffic scheduler queue t-class
profile  type      type  class  profile profile group
-----
@ATM11/0 atm      queue best-effort default default
qp1@ATM11/0 atm-vp  node      sp1      default
qp1@ATM11/0 atm-vc  queue tc1      sp1      qp1
qp1@ATM11/0 atm-vc  queue tc2      sp2      qp2
qp1@ATM11/0 atm-vc  queue tc3      sp3      qp3
qp1@ATM11/0 atm-vc  queue tc4      sp4      qp4
qp1@ATM11/0 atm-vc  queue tc5      sp5      qp5
attachment@ atm-vc ATM11/0.2:
qos      interface rule traffic scheduler queue t-class
profile  type      type  class  profile profile group
-----
qp2@ATM11/0.2 atm-vp  node      sp1      default
qp2@ATM11/0.2 atm-vc  queue tc1      sp1      qp1
qp2@ATM11/0.2 atm-vc  queue tc2      sp2      qp2
qp2@ATM11/0.2 atm-vc  queue tc3      sp3      qp3
@ATM11/0 atm      queue best-effort default default
qp1@ATM11/0 atm-vc  queue tc4      sp4      qp4
qp1@ATM11/0 atm-vc  queue tc5      sp5      qp5

```

Note that:

- ATM best-effort queues are created on ATM interface @ATM11/0 and ATM 11/0.2.
- ATM 11/0.2 subinterface has three queues (traffic classes tc1, tc2, and tc3) that come from QoS profile qp2. Traffic class tc3 is defined in both QoS profile qp1 and qp2. The QoS profile attached closest to the leaf node is used, however. Traffic class tc3 comes from QoS profile qp2, which is attached to ATM subinterface ATM 11/0.2.
- Queues for traffic classes tc4 and tc5 come from QoS profile qp1, which is attached at the ATM major interface.

Example: Diffserv Configuration with Multiple Traffic-Class Groups

In this example configuration, a service provider offers three types of service: data, video-on-demand, and voice. Each service has different QoS requirements. The data users log in and can dynamically subscribe to video and voice services. The data service is a best-effort service. The video service is a *better than best effort* service, which corresponds to assured forwarding PHB. The voice service is a low-latency service, which corresponds expedited forwarding PHB.

You can meet these varying traffic requirements by creating a traffic class group for each of the three services. Creating groups enables you to apply QoS to the group nodes. For example, you could specify the following:

- The voice service gets low-latency, strict priority treatment through the fabric and on egress. You configure an assured rate of 20 Mbps, and shape the traffic to 20 Mbps. Each voice user is shaped to 1 Mbps to support up to 20 voice subscribers without oversubscription. Call admission control ensures that there are no more than 20 simultaneous voice service subscribers. Unused bandwidth is divided among the video and best-effort users.
- The video service is scheduled by the HRR scheduler and gets the hierarchical assured rate. You shape the video traffic to 50 Mbps. Each video service user is assured 1 Mbps, and is shaped to 1 Mbps to support up to 50 video subscribers without oversubscription. Call admission control ensures that there are no more than 50 simultaneous video service subscribers. Unused bandwidth is divided among the best-effort users.
- The best-effort data service is scheduled by the HRR scheduler and gets the bandwidth left over from the voice and video services.

Configure this implementation as follows.

1. Create the video and voice traffic classes. Assign the voice traffic class a strict-priority treatment within the fabric. Manually creating a best-effort traffic class is superfluous because the router creates this class by default.

```
(config)#traffic-class video
(config-traffic-class)#exit
(config)#traffic-class voice
(config-traffic-class)#fabric-strict-priority
(config-traffic-class)#exit
(config)#traffic-class best-effort
(config-traffic-class)#exit
```

2. Create scheduler profiles for the assured forwarding, expedited forwarding, and best-effort groups. Specify strict priority scheduling for the expedited forwarding traffic and shape it to 20 Mbps.

```
(config)#scheduler-profile expeditedGroup
(config-scheduler-profile)#strict-priority
(config-scheduler-profile)#shaping-rate 20000000
(config-scheduler-profile)#assured-rate 20000000
(config-scheduler-profile)#exit
```

3. Assured traffic is not strict, so it is scheduled by the HRR scheduler. Shape the assured traffic to 50 Mbps, and specify the hierarchical assured rate to give assured traffic preferential treatment over best-effort traffic.

```
(config)#scheduler-profile assuredGroup
(config-scheduler-profile)#shaping-rate 50000000
(config-scheduler-profile)#assured-rate hierarchical
(config-scheduler-profile)#exit
```

4. Best effort traffic is also scheduled by the HRR scheduler. You do not apply any shaping for this traffic because it simply gets the leftover bandwidth.

```
(config)#scheduler-profile bestEffortGroup
(config-scheduler-profile)#exit
```

5. Create scheduler profiles for the voice, video, and best-effort service classes. Shape voice and video to 1 Mbps. Because you do not specify a shaping rate, the best-effort traffic can borrow unused bandwidth.

```
(config)#scheduler-profile voice
(config-scheduler-profile)#shaping-rate 1000000
(config-scheduler-profile)#exit
(config)#scheduler-profile video
(config-scheduler-profile)#shaping-rate 1000000
(config-scheduler-profile)#exit
(config)#scheduler-profile best-effort
(config-scheduler-profile)#exit
```

6. Put the video traffic class into the assured-forwarding traffic-class group and specify the group as strict priority. Put the voice traffic class into the expedited-forwarding traffic-class group. Put the best-effort traffic class into the best-effort traffic-class group.

```
(config)#traffic-class-group assured-forwarding auto-strict-priority
(config-traffic-class-group)#traffic-class video
(config-traffic-class-group)#exit
(config)#traffic-class-group expedited-forwarding extended
(config-traffic-class-group)#traffic-class voice
(config-traffic-class-group)#exit
(config)#traffic-class-group best-effort extended
(config-traffic-class-group)#traffic-class best-effort
(config-traffic-class)#exit
```

7. Create a QoS profile that contains the group rules for the assured-forwarding, expedited-forwarding, and best-effort traffic-class groups.

```
(config)#qos-profile qpDiffServExample
(config-qos-profile)#ethernet group assured-fwd scheduler-profile assuredGroup
(config-qos-profile)#ethernet group expedited-fwd scheduler-profile
expeditedGroup
(config-qos-profile)#ethernet group best-effort scheduler-profile bestEffortGroup
(config-qos-profile)#ip node group assured-fwd scheduler-profile default
(config-qos-profile)#ip node group expedited-fwd scheduler-profile default
(config-qos-profile)#ip node group best-effort scheduler-profile default
(config-qos-profile)#ip queue traffic-class voice scheduler-profile voice
(config-qos-profile)#ip queue traffic-class video scheduler-profile video
(config-qos-profile)#ip queue traffic class best-effort scheduler-profile best-effort
(config-qos-profile)#exit
```

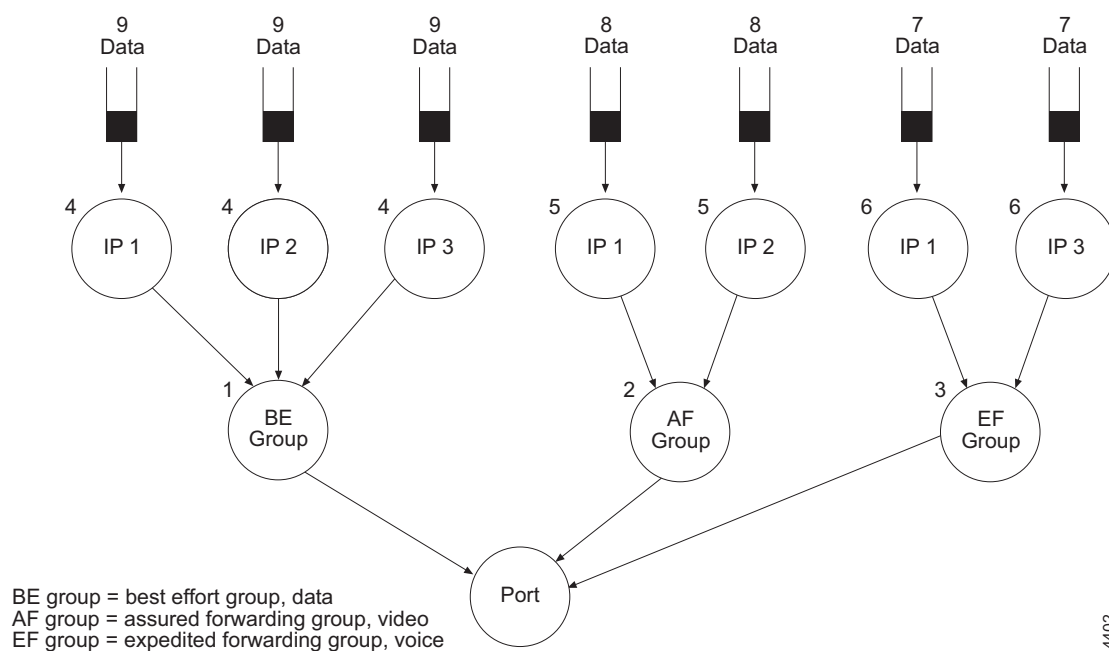
8. Attach the QoS profile to an Ethernet port.

```
(config)#interface fastEthernet 9/0
(config-if)#qos-profile qpDiffServExample
(config-if)#exit
```

Figure 39 shows this configuration with 3 users: IP 1, IP 2, and IP 3.

- IP 1 subscribes to data, video, and voice services.
- IP 2 subscribes to data and video services.
- IP 3 subscribes to data and voice services.

Figure 39: Diffserv Configuration with Multiple Traffic-Class Groups



The following set of commands configures the QoS profile detailed in Step 7 previously. Each line in the profile is known as a *profile rule*. The numbers associated with each rule correspond to the numbers in Figure 39.

```
(config)#qos-profile qpDiffServExample
(1) (config-qos-profile)#ethernet group best-effort scheduler-profile
    bestEffortGroup
(2) (config-qos-profile)#ethernet group assured-fwd scheduler-profile
    assuredGroup
(3) (config-qos-profile)#ethernet group expedited-fwd scheduler-profile
    expeditedGroup
(4) (config-qos-profile)#ip node group best-effort scheduler-profile default
(5) (config-qos-profile)#ip node group assured-fwd scheduler-profile default
(6) (config-qos-profile)#ip node group expedited-fwd scheduler-profile default
(7) (config-qos-profile)#ip queue traffic-class voice scheduler-profile voice
(8) (config-qos-profile)#ip queue traffic-class video scheduler-profile video
(9) (config-qos-profile)#ip queue traffic class best-effort scheduler-profile
    best-effort
```

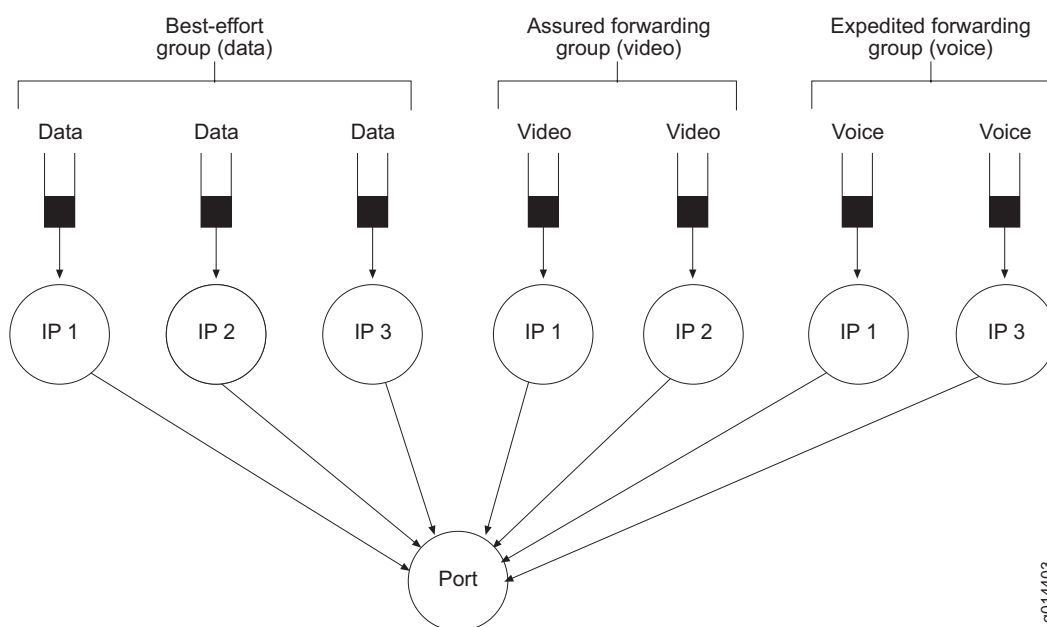

When you specify a group rule within an attached QoS profile, nodes and queue may be attached to group nodes. If the qpDiffServExample QoS profile used in the preceding example did not contain group rules, then the groups would exist with no attachments.

For example, the following set of commands configures the same QoS profile, but with the group removed, as shown in Figure 40.

```
(config)#qos-profile qpDiffServExample
(config-qos-profile)#ip node scheduler-profile default
(config-qos-profile)#ip queue traffic-class voice scheduler-profile voice
(config-qos-profile)#ip queue traffic-class video scheduler-profile video
(config-qos-profile)#ip queue traffic class best-effort scheduler-profile best-effort
```

In this case, the configuration creates the groups but does not place any of the traffic classes into the groups. Figure 40 shows that IP 1, IP 2, and IP 3 contain the ungrouped traffic classes, data, video, and voice.

Figure 40: Diffserv Configuration Without Traffic-Class Groups



Because the BE, AF, and EF groups have no queues, their scheduler attributes (weight, assured rate, shaping rate) do not affect the HRR scheduler's distribution of bandwidth.

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