

Chapter 13

Configuring Implicit and Explicit Constituent Selection for Shaping

This chapter provides information for configuring implicit and explicit constituents on the E-series router.

QoS topics are discussed in the following sections:

- Constituent Selection for Shared Shaping Overview on page 111
- Implicit Constituent Selection Overview on page 113
- Configuring Implicit Constituents for Simple or Compound Shared Shaping on page 119
- Explicit Constituent Selection Overview on page 120
- Configuring Explicit Constituents for Simple or Compound Shared Shaping on page 124

Constituent Selection for Shared Shaping Overview

Shared shaping supports both *implicit* and *explicit* constituent selection. Implicit constituent selection is the easier of the two methods and works well for most cases. With implicit selection, you configure a shared-shaping rate on the best-effort node or queue and QoS locates the other constituents automatically.

Use explicit constituent selection when you want to shape a subset of the interface traffic to the shared rate. An example of this is when you want the sum of best-effort and voice traffic to be shaped to the shared rate, but want video traffic to be exempt from the shared-shaping rate.

Active constituents are selected either implicitly by QoS or explicitly by the user. Active constituents of the simple shared shaper can be any node and queues in named traffic-class groups. Active constituents of the compound shared shaper can be nodes or queues. If you choose a node as an active constituent, queues above it are not active constituents.

Inactive constituents are queues that are stacked above an active node or nodes stacked below active queues. For both of these situations, the shared shaper controls the active constituents, and the legacy scheduler indirectly controls the inactive constituents to achieve the shared rate. The other case for inactive constituents is when you use explicit constituent selection and some of the nodes and queues are explicitly not included in the shared shaper.

To use implicit constituent selection, you specify only the shared-shaping rate and the logical interface. The router identifies the constituents associated with the logical interface type and their allocated bandwidth. This method is appropriate for the typical case where the intent is to shape all subscriber queues to the shared rate.

If you want instead to shape a subset of the queues for a subscriber to the shared rate, the explicit selection process is appropriate. Explicit selection is also useful when you want queues as the active constituents instead of the node below them. By choosing queues you can assign appropriate priority or weights.

Types of Shared Shaper Constituents

The **shared-shaping-constituent** command in a scheduler profile specifies constituents and their attributes. The command has two aspects. For explicit constituent selection, this command specifies the constituents. For the compound shared shaper only, this command specifies scheduling attributes of shared shaping: the shared priority and the shared weight.

A shared shaper can be one of the following four types:

- Simple implicit—Constituents are best-effort node or queues, and all nodes and queues in named traffic-class groups.
- Simple explicit—The software selects constituents based on the **shared-shaping-constituent** command. The weight and priority attributes of the **shared-shaping-constituent** command are ignored, because the simple shared shaper does not allocate bandwidth among constituents; instead it controls just the best-effort queue or node.
- Compound implicit—Constituents are selected automatically by the software. If a node exists in a given traffic-class group, the node is active and the queues stacked above it are inactive constituents. The **shared-shaping-constituent** command does not affect constituent selection. However, if the command is present for a constituent that was implicitly selected, the software configures that constituent with the shared priority and shared weight as indicated.
- Compound explicit—The software selects constituents based on the shared priority and shared weight configured with the **shared-shaping-constituent** command. If no attributes are specified, the software supplies a shared priority consistent with the legacy scheduler configuration.

Table 11 compares implicit and explicit shared shaping.

Table 11: Comparison of Implicit and Explicit Shared Shaping

Implicit Shared Shaping	Explicit Shared Shaping
<ul style="list-style-type: none"> ■ To specify the logical interface for shared shaping, associate a scheduler profile that includes the shared-shaping-rate command or the shared-shaping-rate simple command with a best-effort node or queue. 	<ul style="list-style-type: none"> ■ To specify the logical interface for shared shaping, associate a scheduler profile that includes the shared-shaping-rate rate explicit-constituents command or the shared-shaping-rate rate simple explicit-constituents command with a best-effort node or queue.
<ul style="list-style-type: none"> ■ Constituents consist of all nodes and queues for the same logical interface type. 	<ul style="list-style-type: none"> ■ Constituents consist of all nodes and queues for the same logical interface type.
<ul style="list-style-type: none"> ■ Active constituents are automatically selected from all constituents according to the implicit shared shaping rules. 	<ul style="list-style-type: none"> ■ Active constituents are explicitly selected from all constituents by association with a scheduler profile that includes the shared-shaper-constituent command. ■ If the scheduler profile associated with a constituent does not include this command, then the constituent is not active and is not shaped by the shared shaper.

Related Topics

- Implicit Constituent Selection Overview on page 113
- Configuring Implicit Constituents for Simple or Compound Shared Shaping on page 119
- Explicit Constituent Selection Overview on page 120
- Configuring Explicit Constituents for Simple or Compound Shared Shaping on page 124

Implicit Constituent Selection Overview

The implicit selection process for simple and compound shared shaping are the same. The process operates according to the following rules:

1. The point at which the scheduler profile that contains a **shared-shaping-rate** command is associated with a best-effort node or best-effort queue determines the logical interface type that the shared shaper applies to. Logical interface types include IP, VP, VC, VLAN, S-VLAN, and so on.
2. All nodes and queues for the same logical interface are potential constituents.
3. The best-effort node is selected if you configure node-based shared shaping. The best-effort queue is selected if you configure queue-based shared shaping. If you configure both, then the best-effort node is selected over the best-effort queue.
4. Non-best-effort queues are selected.

The implicit selection process for compound shared shaping operates according to the following rules:

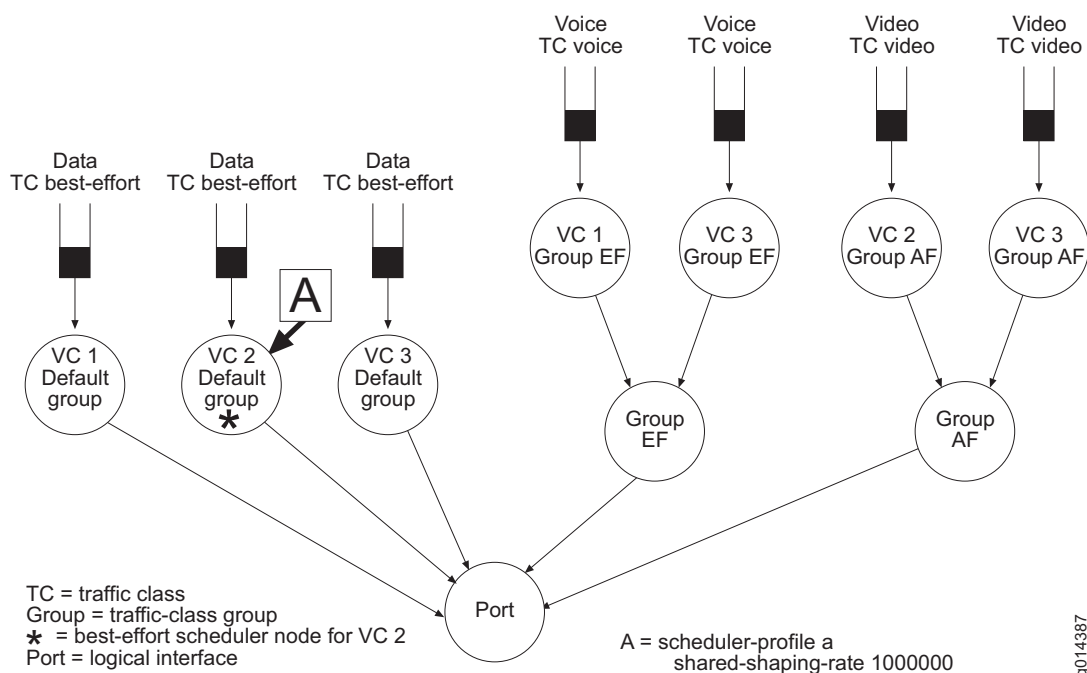
1. The point at which the scheduler profile that contains a **shared-shaping-rate** command is associated with a best-effort node or best-effort queue determines the logical interface type that the shared shaper applies to. Logical interface types include IP, VP, VC, VLAN, and S-VLAN.
2. All nodes and queues for the same logical interface are potential constituents.
3. Nodes are selected over queues.

For example, suppose a shared shaper is associated with a particular interface type. A node for that interface type is present and has a queue for that interface type stacked above it. The node is selected and becomes an active constituent; the queue is not selected.

Now suppose a shared shaper is associated with a logical interface at the best-effort node, and a second shared shaper is simultaneously associated with the same interface at the best-effort queue. In this case, the node is selected as the constituent, because nodes are selected over queues.

In Figure 29, scheduler profile A includes a shared-shaping rule, and is associated with the best-effort node for VC 2. The constituents are all the scheduler objects associated with VC 2: VC 2 nodes and VC 2 queues. Nodes are selected over queues, so the implicitly selected active constituents are the VC 2 default group node, the VC 2 Group EF node, and the VC 2 Group AF node.

Figure 29: Implicit Constituent Selection for Compound Shared Shaper at Best-Effort Node



In Figure 30, scheduler profile B is associated with the best-effort queue for VC 3. This association indicates that the logical interface type being shared is VC. The constituents are all the scheduler objects associated with VC 3: VC 3 nodes and VC 3 queues. Nodes are selected over queues, so the implicitly selected active constituents for profile B's shared shaper are the VC 3 default group queue, the VC 3 Group EF node, and the VC 3 Group AF node. The VC 3 default group queue is selected instead of the VC 3 default group node because the shared shaper is associated with that best-effort queue.

Figure 30: Implicit Constituent Selection for Compound Shared Shaper at Best-Effort Queue

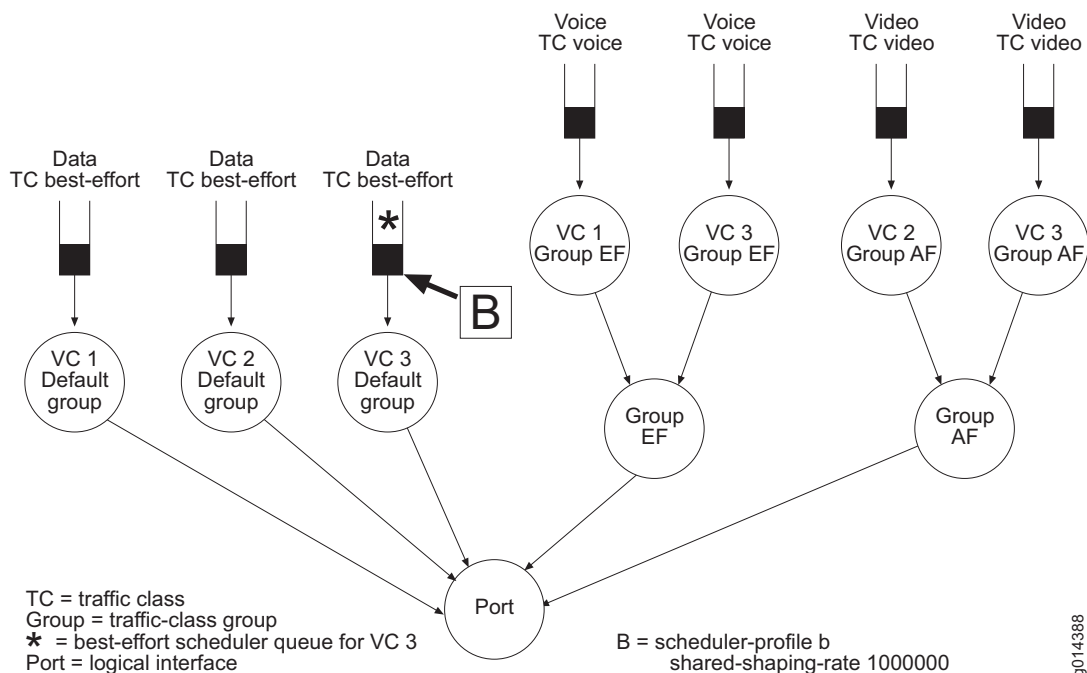


Figure 30 illustrates other examples of implicit constituent selection. It does not reflect typical configurations, but includes a mixture of interface types: IP, VC, and VP. If only scheduler profile A is applied, the associated interface is VC 1. The selected constituents then consist of the VC 1 best-effort node, the VC 1 TC voice queue, and the VC 1 TC video queue.

If only scheduler profile B is applied, the associated interface is IP 1. The selected constituents then consist of the IP 1 best-effort queue, the IP 1 TC voice queue, and the IP 1 TC video queue.

If only scheduler profile C is applied, the associated interface is VP 1. The selected constituents then consist of the VP 1 default group node, the VP 1 Group EF node, and the VP 1 Group AF node.

Implicit Bandwidth Allocation for Compound Shared Shaping

After selecting the implicit constituents for compound shared shaping, the router places the constituents in an order that determines how the constituents can claim a share of the available shared bandwidth.

When it implements compound implicit shared shapers, the software selects attributes for the active constituents consistent with the hierarchical scheduler.

- Auto-strict nodes and queues have the highest priority.
- Nodes and queues in extended traffic-class groups are next.
- Nodes and queues in the default traffic-class group have the lowest priority.

For example, suppose a compound shared shaper has a rate of 2 Mbps. The shared shaper has three active constituents: the best-effort node, a voice queue in the auto-strict traffic-class group, and a video queue in an extended traffic-class group. For compound implicit shared shaping, the shared shaper assigns the voice queue all the 2 MB, the video queue the next priority, and the best-effort node the last priority. The voice queue is unlikely to drop because it has highest priority in the hierarchical scheduler as well as highest priority within its shared shaper. The video queue is less likely to drop, but you must still take care that the hierarchical scheduler is provisioned to allocate the proper assured bandwidth to video. The shared shaper can shape, or deny, bandwidth to its constituents, but it cannot allocate assured bandwidth in the hierarchical scheduler.

The compound shared-shaper mechanism also works as follows. In the legacy scheduler, weight and shaping rate are independent attributes that together determine bandwidth allocation. The scheduler allocates bandwidth based on relative weights, and the shaper can deny that bandwidth when the shaping rate is reached. With the shared shaper in effect, two independent shaping rates must be satisfied for the queue or node to dequeue. A deficit in either type of shaping bounds the bandwidth.

As a general way of predicting the scheduler behavior, if the physical port is congested because many queues and nodes are competing in the hierarchical scheduler, the legacy weights and shaping rates dominate the scheduler outcome. If the hierarchical scheduler is not congested, a shared shaper configured for a logical interface dominates the outcome for the traffic scheduled through that logical interface.

The compound shared shaper orders constituents, and allocates shared bandwidth to them, according to the following rules:

1. Strict constituents in the auto-strict-priority traffic-class group

For multiple strict-priority traffic-class groups, bandwidth allocation order is the same order in which the additional strict traffic class groups were configured. You can issue the **show traffic-class-groups** command to view this order.

2. Strict constituents in extended traffic-class groups

For multiple extended traffic class groups, bandwidth allocation order is the same order in which the traffic class groups were configured. You can issue the **show traffic-class-groups** command to view this order.

3. Strict constituents in the default group
4. Weighted constituents in the auto-strict-priority traffic class group
5. Weighted constituents in extended traffic class groups
6. Weighted constituents in the default group

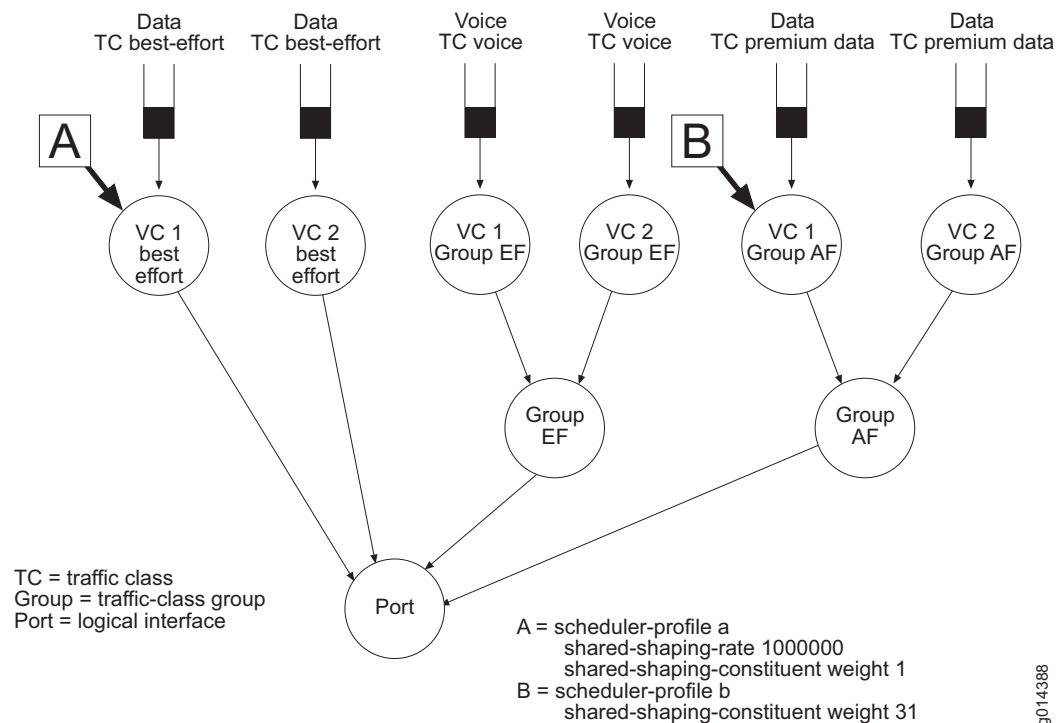
By default, strict constituents transmit traffic at a rate up to the lesser of their shared-shaping rate or the legacy shaping rate. Individual strict constituents can be allocated any bandwidth value less than the shared rate. The sum of all constituent rate credits does not have to be less than the shared rate. Individual constituent rates are not capped, because a particular traffic class often does not exceed a limit because of admission control, or because the class is policed at some point in the path.

Unlike strict constituents, which can consume bandwidth up to the legacy shaping rate or the shared-shaping rate, weighted constituents share bandwidth with their peers solely in proportion to their shared-shaping-weight. A higher weight value grants the constituent a greater proportion of the available bandwidth.

Although a shared shaper can be applied to up to eight constituents, only four of these can be weighted constituents. If you configure more than four weighted constituents as part of the same shared shaper, the first four are treated as weighted constituents but the remainder are handled as strict constituents, generating a warning message.

Weighted Compound Shared Shaping Example

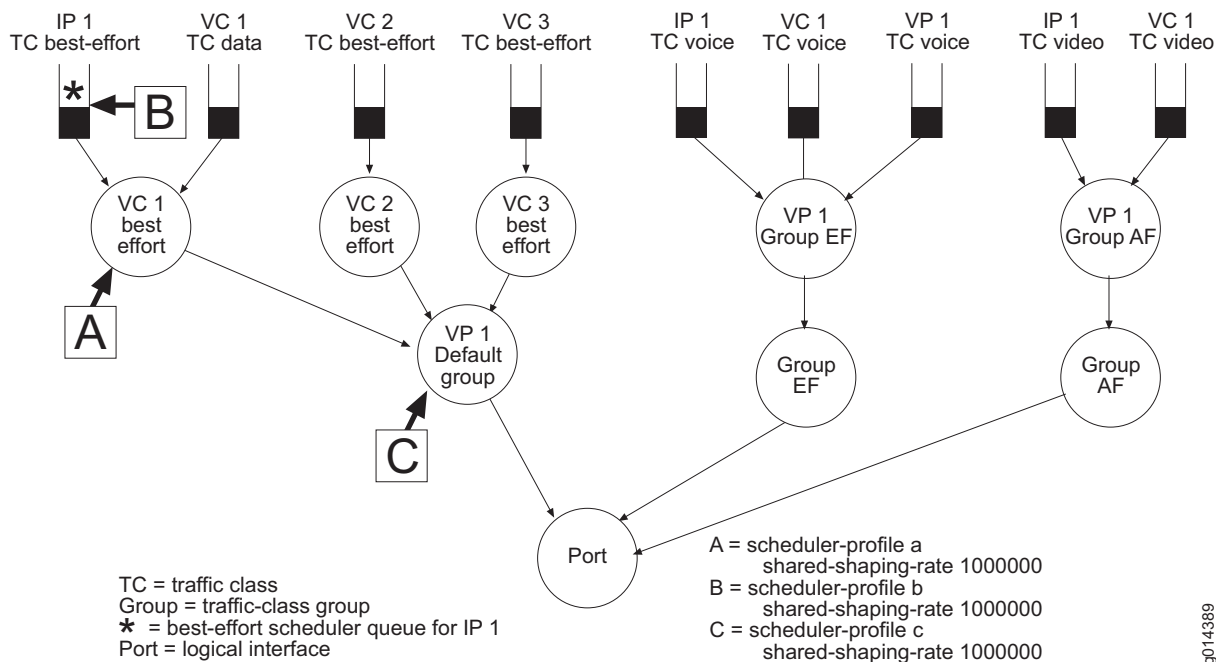
Weighted shared shaping is most useful for sharing bandwidth between traffic classes carrying TCP data. Figure 31 on page 118 shows an application of weighted shared shaping where weighted constituents span multiple traffic class groups, making them ineligible for legacy weighted scheduling. Best-effort data and premium data constituents are weighted.

Figure 31: Weighted Shared Shaping

Scheduler profile A specifies the shared-shaping rate of 1 Mbps for the best-effort node, which is associated with a VC logical interface. The node is further configured with a weight of 1. Scheduler profile B specifies the VC 1 AF node as a weighted constituent with a weight of 31.

The implicitly selected constituents of the shared shaper are the VC 1 best-effort node, the VC 1 AF group node, and the VC 1 EF group node. Bandwidth is allocated as follows:

- The VC 1 EF group node is strict and can transmit up to the shared-shaping rate of 1 Mbps. Any remaining bandwidth is available to the remaining constituents.
- The VC 1 AF group node is weighted with the VC 1 best-effort node. The sum of the constituent weights is 32. With a weight of 31, the VC 1 AF group node can transmit 31/32nds of the available bandwidth when both constituents are competing for bandwidth.
- The VC 1 best-effort node is weighted with VC 1 AF group node. The sum of the constituent weights is 32. With a weight of 1, the VC 1 best-effort node can transmit 1/32 of the available bandwidth when both constituents are competing for bandwidth.

Figure 32: Implicit Constituent Selection for Compound Shared Shaper: Mixed Interface Types

Configuring Implicit Constituents for Simple or Compound Shared Shaping

There are two types of implicit constituents:

- Simple implicit—Constituents are best-effort node or queues, and all nodes and queues in named traffic-class groups.
- Compound implicit—Constituents are selected automatically by the software. If a node exists in a given traffic-class group, the node is active and the queues stacked above it are inactive constituents.

Before you configure implicit constituents:

- Configure the traffic classes and traffic-class groups.

See *Configuring Traffic Classes That Define Service Levels* on page 15 and *Configuring Traffic-Class Groups That Define Service Levels* on page 15.

To configure implicit constituents:

1. Create the scheduler profile.

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

2. Configure the shared shaper.

To configure a simple shared shaper:

```
host1(config-scheduler-profile)#shared-shaping-rate 128000 bps
```

To configure a compound shared shaper:

```
host1(config-scheduler-profile)#shared-shaping-rate 128000 burst 32767 compound
```

3. (Optional) For compound shared shapers, specify the attributes for the constituent.

```
host1(config-scheduler-profile)#shared-shaping-constituent weight 28
```

Including this command does not affect how the system selects the compound implicit constituent. If the command is present for a constituent that was implicitly selected, the software configures that constituent using the strict-priority or weight attributes.

After you configure implicit constituents:

- Configure the scheduler hierarchy with the best-effort nodes and queues.

See *Configuring a QoS Profile* on page 136.

Related Topics

- [Constituent Selection for Shared Shaping Overview on page 111](#)
- [Implicit Constituent Selection Overview on page 113](#)
- **scheduler-profile** command
- **shared-shaping-constituent** command
- **shared-shaping-rate** command

Explicit Constituent Selection Overview

If you want only a subset of the queues for a subscriber to be shaped to the shared rate, then you must explicitly identify the desired constituents rather than accepting the implicitly selected constituents.

For compound shared shaping, explicit selection is also useful when you want queues as the active constituents instead of the node below them. By choosing queues you can assign appropriate priority or weights.

In the set of nodes and queues for a logical interface, only scheduler objects associated with a scheduler profile that includes a **shared-shaping-constituent** command are considered constituents. Objects that are not explicitly selected are exempt from the shared shaper.

To identify the constituents for simple shared shaping, include the **explicit-constituents** keyword with the **shared-shaping-rate simple** command in a scheduler profile that you associate with a best-effort node or queue to identify the logical interface.



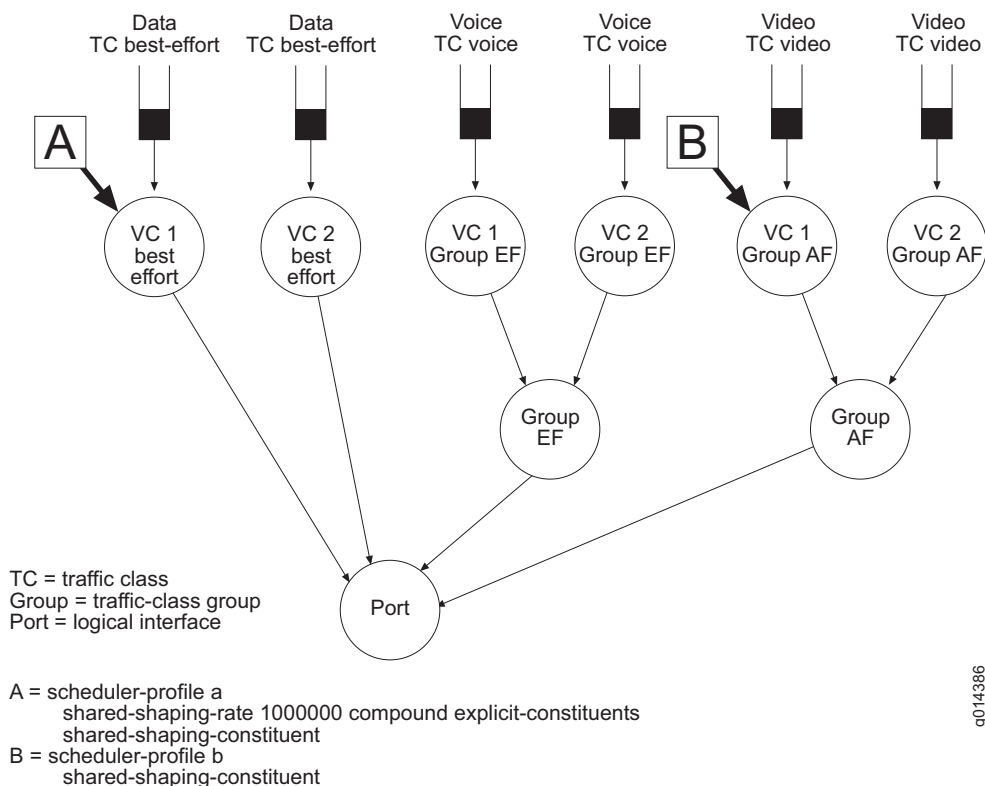
NOTE: If you explicitly specify both a node and the queues stacked above the node as constituents in a scheduler profile, compound shared shaping uses the node as the constituent.

For compound shared shaping, omit the **simple** keyword. For a compound shared shaper, you can further designate the explicit constituents as priority or weighted.

Explicit Shared Shaping Example

In Figure 33, two scheduler profiles are applied to scheduler objects VC 1 best effort node, VC 1 AF node, and VC 1 EF node. The shared-shaping-constituent command in each profile specifies that the associated object is an explicit constituent of the shared shaper.

Figure 33: Explicit Constituent Selection



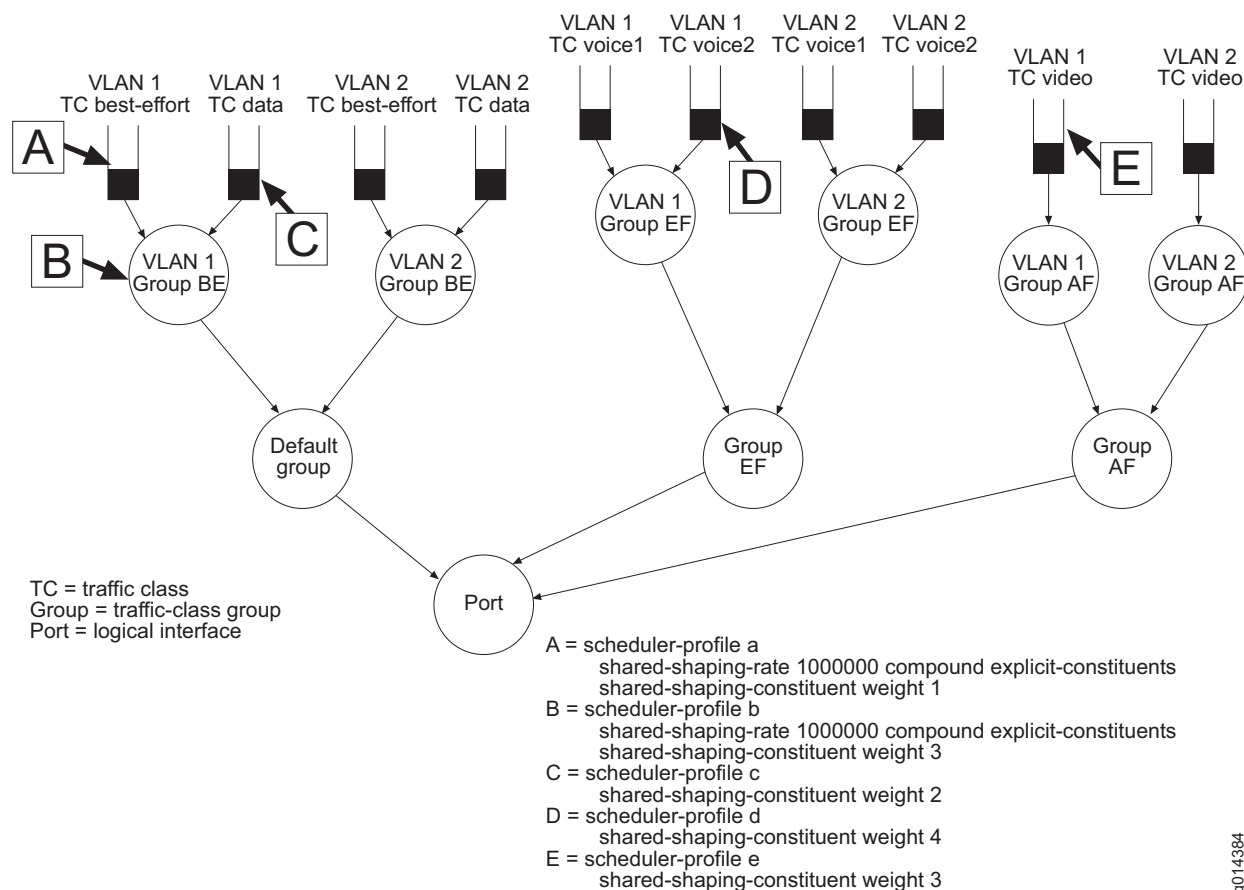
In this example, the VC shared shaper has two explicit constituents, the VC 1 best effort node and the VC 1 Group EF node. By default, these constituents are considered to be strict constituents with a priority of 8.

If implicit selection rules are followed in this example, the association of the shared shaper with the VC 1 best-effort node selects the VC 1 best effort node, the VC 1 Group EF node, and the VC 1 Group AF node.

Explicit Weighted Compound Shared Shaping Examples

Figure 34 illustrates a case where scheduler profiles A, B, C, D, and E are applied to scheduler objects.

Figure 34: Case 1: Explicit Constituent Selection with Weighted Constituents



In Case 1, scheduler profile A associates the shared-shaping rate with the VLAN 1 best-effort queue. Table 12 lists the explicit constituents of the shared shaper and the bandwidth allocated to each constituent:

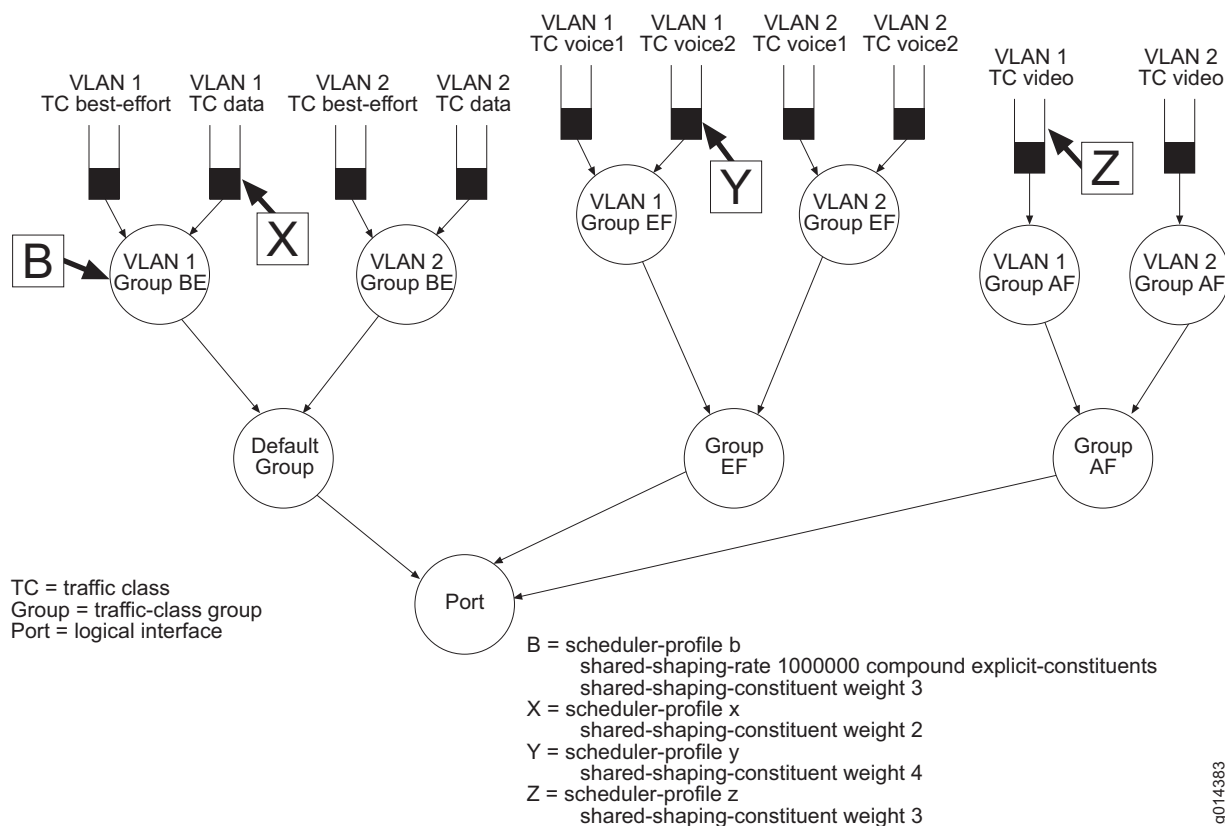
Table 12: Bandwidth Allocation for Case 1 Explicit Constituents

Explicit Constituent	Bandwidth Allocation
VLAN 1 TC voice1 queue	Strict constituent that can consume up to its legacy shaping-rate.
VLAN 1 TC voice2 queue	Weighted constituent that shares bandwidth with its weighted shared shaper siblings in a proportion of 4/10.
VLAN 1 TC video queue	Weighted constituent that shares bandwidth with its weighted shared shaper siblings in a proportion of 3/10.

Table 12: Bandwidth Allocation for Case 1 Explicit Constituents (continued)

Explicit Constituent	Bandwidth Allocation
VLAN 1 TC data queue	Weighted constituent that shares bandwidth with its weighted shared shaper siblings in a proportion of 2/10.
VLAN 1 TC best-effort queue	Weighted constituent that shared bandwidth with weighted shared shaper siblings in a proportion of 1/10.

Figure 35 illustrates another case where scheduler profiles B, X, Y, and Z are applied to scheduler objects. Each profile assigns a weight to an explicit constituent.

Figure 35: Case 2: Explicit Constituent Selection with Weighted Constituents

In Case 2, scheduler profile B associates the shared-shaping rate with the best-effort node for VLAN 1. Table 13 lists the explicit constituents of the shared shaper and the bandwidth allocated to each constituent:

Table 13: Bandwidth Allocation for Case 2 Explicit Constituents

Explicit Constituent	Bandwidth Allocation
VLAN 1 TC voice1 queue	Strict constituent that can consume up to its legacy shaping-rate.
VLAN 1 TC voice2 queue	Weighted constituent that shares bandwidth with its weighted shared shaper siblings in a proportion of 4/10.

Table 13: Bandwidth Allocation for Case 2 Explicit Constituents (continued)

Explicit Constituent	Bandwidth Allocation
VLAN 1 TC video queue	Weighted constituent that shares bandwidth with its weighted shared shaper siblings in a proportion of 3/10.
Best-effort node for VLAN 1	Weighted constituent that shared bandwidth with weighted shared shaper siblings in a proportion of 3/10. NOTE: The node is selected as the constituent when both the node and the queues stacked over node are specified in a scheduler profile.

Configuring Explicit Constituents for Simple or Compound Shared Shaping

You can specify explicit constituents and set the attributes of both implicit and explicit shared-shaping constituents that determine how bandwidth is allocated to them.

There are two types of explicit constituents:

- Simple explicit constituents—The software selects constituents based on the **shared-shaping-constituent** command. The weight and priority attributes of the **shared-shaping-constituent** command are ignored, because the simple shared shaper does not allocate bandwidth among constituents; instead it controls just the best-effort queue or node.
- Compound explicit—The software selects constituents based on the configured shared priority and shared weight in the **shared-shaping-constituent** command. If no attributes are specified, the software supplies a shared priority consistent with the legacy scheduler configuration. You can specify a constituent as strict (priority) or weighted. Strict-priority constituents are allocated bandwidth ahead of weighted constituents.

Before you configure explicit constituents:

- Configure the traffic classes and traffic-class groups.

See *Configuring Traffic Classes That Define Service Levels* on page 15 and *Configuring Traffic-Class Groups That Define Service Levels* on page 15.

To configure explicit constituents:

1. Create the scheduler profile.

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

2. Configure the shared-shaper and specify that you do not want the router to identify shared shaper constituents associated with the logical interface.

To configure a simple shared shaper:

```
host1(config-scheduler-profile)#shared-shaping-rate 128000 bps
```

To configure a compound shared shaper:

host1(config-scheduler-profile)#**shared-shaping-rate 128000 burst 32767 compound explicit-constituents**

3. Specify the attributes for the explicit constituent.

host1(config-scheduler-profile)#**shared-shaping-constituent weight 28**

You can specify a constituent as strict (priority) or weighted. Strict-priority constituents are allocated bandwidth ahead of weighted constituents.

You can optionally set a value that determines the precedence of a constituent among its peers (strict or weighted) for claiming bandwidth.

For strict-priority constituents, the priority range is 1–8 and the default value is 8. A lower value correlates to a higher claim.

For weighted constituents, the range is 1–31 and the default value is 8. The weights of all sibling weighted constituents are added together. Then each weighted constituent is allocated bandwidth according to the proportion of its weight to the total.

Related Topics

- [Constituent Selection for Shared Shaping Overview on page 111](#)
- [Explicit Constituent Selection Overview on page 120](#)
- **scheduler-profile** command
- **shared-shaping-constituent** command
- **shared-shaping-rate** command

