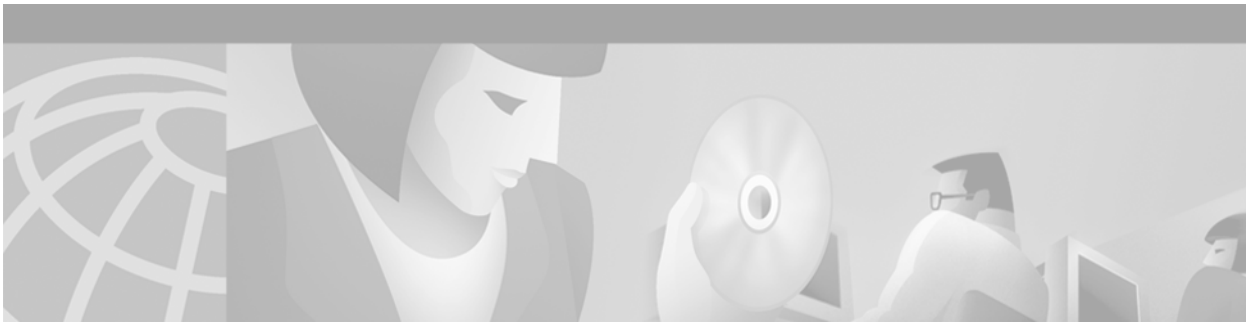

Distributed Traffic Shaping

This feature module describes the distributed Traffic Shaping (DTS) feature. It includes information on the benefits of the new feature, supported platforms, prerequisites, configuration examples and command references.

This document includes the following sections:

- Feature Overview, page 1
- Supported Platforms, page 3
- Supported Standards, MIBs, and RFCs, page 3
- Prerequisites, page 4
- Configuration Tasks, page 4
- Monitoring and Maintaining DTS, page 6
- Configuration Examples, page 6
- Command Reference, page 9
- Glossary, page 18
- Appendix, page 18

Feature Overview

Table 1 Feature History

Cisco IOS Release	Enhancement
12.2(8)T	This feature became available for Multilink PPP.
12.1(5)T	This feature was introduced on Cisco IOS Release 12.1 T.
12.0(5)XE	This feature was introduced.

Many enterprise and service provider customers need to shape traffic in their networks and sometimes to shape IP traffic independent of the underlying interface. In other cases, the goal is to perform traffic shaping to ensure adherence to committed information rates on Frame Relay links.

The DTS feature is one element used to manage the bandwidth of an interface to avoid congestion, to meet remote site requirements, and to conform to a service rate that is provided on that interface.

DTS uses queues to buffer traffic surges that can congest a network. Data is buffered and then sent into the network at a regulated rate. This ensures that traffic will behave to the configured descriptor, as defined by command information rate (CIR), Committed Burst (Bc), and Excess Burst (Be). With the defined average bit rate and burst size that is acceptable on that shaped entity, you can derive a time interval value.

The Be allows more than the Bc to be sent during a time interval under certain conditions. Therefore, DTS provides two types of **shape** commands: **average** and **peak**. When **shape average** is configured, the interface sends no more than the Bc for each interval, achieving an average rate no higher than the CIR. When **shape peak** is configured, the interface sends Bc plus Be bits in each interval.

In a link layer network such as Frame Relay, the network sends messages with the forward explicit congestion notification (FECN) or backwards explicit congestion notification (BECN) if there is congestion. With the DTS feature, the traffic shaping adaptive mode takes advantage of these signals and adjusts the traffic descriptors. This approximates the rate to the available bandwidth along the path.

Benefits

DTS provides the following key benefits:

- Offloads traffic shaping from the route switch processor (RSP) to the Versatile Interface Processor (VIP).
- Supports up to 200 shape queues per VIP, supporting up to OC-3 rates when the average packet size is 250 bytes or greater and when using a VIP2-50 or better with 8MB of SRAM. Line rates below T3 are supported with a VIP2-40.
- Configures distributed traffic shaping at the interface level or subinterface level.
- Shaping based on the following traffic match criteria:
  - User-defined classes
  - All traffic on the physical or subinterface
  - Traffic classified via simple and extended IP access control lists (ACLs)
  - Traffic classified by quality of service (QoS) group (an internal packet label applied upstream by a previous feature)
  - Traffic classified by IP precedence bits in the ToS (type of service) byte
  - Traffic classified by IP differentiated services code points (DSCP)
- Optional configuration to respond to Frame Relay network congestion (indicated by the presence of BECN or ForeSight signals) by reducing the shaped-to rate for a period of time until congestion is believed to have subsided. Supports FECN, BECN, and ForeSight Frame Relay signaling.

Restrictions

DTS does not support the following:

- Fast EtherChannel, Tunnel, VLANs, and dialer interface
- Any VIP below a VIP2-40

Note A VIP2-50 is strongly recommended when the aggregate line rate of the port adapters on the VIP is greater than DS3. A VIP2-50 card is required for OC-3 rates.

Related Documents

For information on non-distributed traffic shaping in Cisco IOS Release 12.1 T, see the Class-Based Shaping feature module.

For related information on DTS, refer to the following documents:

- Cisco IOS Release 12.1 *Quality of Service Solutions Configuration Guide*
- Cisco IOS Release 12.1 *Quality of Service Solutions Command Reference*
- Cisco IOS Release 12.0 *Configuring Generic Traffic Shaping*
- Cisco IOS Release 12.0 *Configuring Frame Relay and Frame Relay Traffic Shaping*

Supported Platforms

This feature runs on Cisco 7500 series routers with VIP2-40, VIP2-50, or higher.

Supported Standards, MIBs, and RFCs

MIBs

- No new or modified MIBs are supported by this feature.

RFCs

- No new or modified RFCs are supported by this feature.

Prerequisites

Distributed Cisco Express Forwarding

Distributed Cisco Express Forwarding (DCEF) must be enabled on the interface before DTS can be enabled.

Policy Maps and Class Maps

A policy map and class maps must be created before DTS is enabled. (See "Configuring a Policy with DTS in the Policy Map" on page 5.)

Configuration Tasks

See the following sections for configuration tasks for DTS. Each task in the lists indicates if the task is optional or required.

- Defining Class Maps (Required)
- Configuring a Policy with DTS in the Policy Map (Required)
- Attaching the Service Policy and Enabling DTS (Required)
- Modifying DTS for an Existing Policy Map Class (Required)

Defining Class Maps

DTS is enabled using the Modular QoS CLI. The first step of enabling any feature using the Modular QoS CLI is creating a class map.

For information on the Modular QoS CLI, see the *Modular Quality of Service Command Line Interface* document on CCO or the Documentation CD-ROM.

For information on creating a class map, see the Defining a Traffic Class" section of the *Modular Quality of Service Command Line Interface* document.

Configuring a Policy with DTS in the Policy Map

To enable DTS you must create a policy map. You can configure class policies for as many classes as are defined on the router up to the maximum of 256.

To configure a policy map, use the **policy-map** command to specify the policy map name, then use the following configuration commands to configure class name, traffic shaping, and class policy**.**

Traffic is directed to the policy map default class if it does not satisfy the match criteria of any other classes whose policies are defined in the policy map.

	Command	Purpose
Step 1	`Router(config)# policy-map policy-name`	Specifies the name of the policy map to be created.
Step 2	`Router(config-pmap)# class class-name`	Specifies the name of a predefined class included in the service policy. The class was defined in the previous "Defining Class Maps" step of this process.
Step 3	`Router(config-pmap-c)# shape <average | peak> <mean rate>[<burst size> [<excess burst size>]]`	Specifies the target bits per second (bps) rate.

Attaching the Service Policy and Enabling DTS

To attach a policy map to the interface and enable DTS on the interface, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# service-policy output policy-name`	Enables DTS and attaches the specified policy map to the interface.

Modifying DTS for an Existing Policy Map Class

To change the amount of bandwidth allocated for an existing class, use the following commands:

	Command	Purpose
Step 1	`Router(config)# policy-map policy-name`	Specifies the name of the service-policy map containing the class to be modified.
Step 2	`Router(config-pmap)# class class-name`	Specifies the name of a class whose bandwidth you want to modify.
Step 3	`Router(config-pmap-c)# shape [average | peak] mean-rate [[burst-size] [excess-burst-size]]`	Specifies the new values for the DTS feature.

Monitoring and Maintaining DTS

To monitor and maintain the DTS feature, use the following commands:

Command	Purpose
Router# **show interface** [*interface-name*] **shape**	Displays detail status of the traffic shaping.
Router# **show policy** *policy-name*	Displays the configuration of all classes composing the specified policy map.
Router# **show policy** *policy-name* **class** *class-name*	Displays the configuration of the specified class of the specified policy map.

Configuration Examples

This section provides the following configuration examples:

- DTS on Main Interface
- Class-based DTS on Main Interface
- DTS on Frame Relay Point-to-Point Subinterface
- Class-based DTS on Frame Relay Point-to-Point Subinterface

DTS on Main Interface

In the following example, traffic that goes out on interface pos1/0/0 is shaped at the rate of 10Mbits/sec.

```
router(config)# class-map class-interface-all
router(config-cmap)# match any
router(config-cmap)# exit
router(config)# policy-map dts-interface-all-action
router(config-pmap)# class class-interface-all
router(config-pmap-c)# shape average 10000000
router(config-pmap-c)# exit
router(config)# interface pos1/0/0
router(config-if)# service-policy output dts-interface-all-action
```

Class-based DTS on Main Interface

In the following example, two classes are created and the match criteria is defined based on the access list number. Traffic that goes out on interface fdi4/0/0 and matches the criteria in access list 10 is shaped to 16Mbps. Traffic that matches the criteria in access list 20 is shaped to 8 Mbps.

Note The following IP addresses are examples only.

```
router(config)# access-list 10 permit 171.69.0.0
router(config)# access-list 20 permit 192.168.0.0
router(config)# class-map class1
router(config-cmap)# match access-group 10
router(config-cmap)# exit
router(config)# class-map class2
router(config-cmap)# match access-group 20
router(config-cmap)# exit
router(config)# policy-map dts-interface-class-action
router(config-pmap)# class class1
router(config-pmap-c)# shape average 16000000
router(config-pmap-c)# exit
router(config-pmap)# class class2
router(config-pmap-c)# shape average 8000000
router(config-pmap-c)# exit
router(config-pmap)# interface fd4/0/0
router(config-if)# service-policy output dts-interface-class-action
```

DTS on Frame Relay Point-to-Point Subinterface

In the following example, traffic going out on sub-interface 6/1/0.1 or 6/1/0.2 is shaped to 1 Mbps.

```
router(config)# class-map class-p2p-all
router(config-cmap)# match any
router(config-cmap)# exit
router(config)# policy-map dts-p2p-all-action
router(config-pmap)# class class-p2p-all
router(config-pmap-c)# shape average 1000000
router(config-pmap-c)# exit
router(config)# interface hssi6/1/0.1 point-to-point
router(config-subif)# service-policy output dts-p2p-all-action
router(config-subif)# exit
router(config)# interface hssi6/1/0.2 point-to-point
router(config-subif)# service-policy output dts-p2p-all-action
```

Class-based DTS on Frame Relay Point-to-Point Subinterface

In the following example, two classes are created with the match criteria defined by QoS number. Traffic goes out on subinterface 6/1/0.5 or 6/1/0.6 with the QoS-group number 30 shaped to 800 kbps and the QoS-group number 40 shaped to 1.6 Mbps. For the incoming Frame Relay packet that has the FECN bit on, a BECN message is sent out from the interface. For the outgoing Frame Relay packets that match the QoS-group number 40, the shape rate could be further reduced to 800 kbps.

```
router(config)# class-map class3
router(config-cmap)# match qos-group 30
router(config-cmap)# exit
router(config)# class-map class4
router(config-cmap)# match qos-group 40
router(config-cmap)# exit
router(config)# policy-map dts-p2p-class-action
router(config-pmap)# class class3
router(config-pmap-c)# shape average 800000
router(config-pmap-c)# shape fecn-adapt
router(config-pmap-c)# exit
router(config-pmap)# class class4
router(config-pmap-c)# shape average 1600000
router(config-pmap-c)# shape adaptive 800000
router(config-pmap-c)# exit
router(config)# interface serial 6/1/0.5 point-to-point
router(config-subif)# service-policy output dts-p2p-class-action
router(config-subif)# exit
router(config)# interface serial 6/1/0.6 point-to-point
router(config-subif)# service-policy output dts-p2p-class-action
```

Command Reference

This section documents new commands. All other commands used with this feature are documented in the Cisco IOS Release 12.1 command reference publications.

- **shape**
- **shape adaptive**
- **shape fecn-adapt**
- **show interfaces shape**

In Cisco IOS Release 12.0(1)T or later, you can search and filter the output for **show** commands. This functionality is useful when you need to sort through large amounts of output, or if you want to exclude output that you do not need to see.

To use this functionality, enter a **show** command followed by the "pipe" character (|), one of the keywords **begin**, **include**, or **exclude**, and an expression that you want to search or filter on:

command **|{begin | include | exclude}** *regular-expression*

Following is an example of the **show interfaces shape** command in which you want the command output to begin with the first line where the expression "Peak Rate" appears:

show interfaces shape | begin PeakRate

For more information on the search and filter functionality, refer to the Cisco IOS Release 12.0(1)T feature module titled *CLI String Search*.

Sample command reference pages follow. Refer to these samples for standard wording, syntax conventions, and format.

shape

Use the **shape** configuration command to shape traffic to the indicated bit rate according to the algorithm specified. The **no** form of this command removes shaping and leaves the traffic unshaped.

shape [**average | peak**] *mean-rate* [[*burst-size*] [*excess-burst-size*]]

no shape shape [**average | peak**]

Syntax Description

average	Bc is the maximum number of bits sent out in each interval.
peak	Bc+Be is the maximum number of bits sent out in each interval.
mean rate	Also called CIR, indicates the bit rate used to shape the traffic, in bps (bits per second). When this command is used with BECN approximation, the bit rate is the upper bound of the range of bit rates that will be permitted.
burst size	The number of bits in a measurement interval (Bc). (optional)
excess burst size	The acceptable number of bits permitted to go over the burst size (Be). (optional)

Defaults

See Usage Guidelines for burst size.

Command Modes

Policy map class configuration

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.1(5)T	This command became available for Cisco IOS Release 12.1 T.

Usage Guidelines

The measurement interval is Bc/CIR. Bc cannot be set to 0. If this is too large (greater than 128 ms), the system subdivides it into smaller intervals.

If you do not specify Bc and Be, the algorithm decides the default values for the shape entity. The algorithm uses a 4 ms measurement interval, so Bc will be CIR * 4/1000.

Burst sizes larger than the default Bc need to be explicitly specified. The larger the Bc, the longer the measurement interval. This may affect voice traffic latency, if applicable.

When Be is not configured, the default value is equal to Bc.

Examples

The following example configures a shape entity with CIR 1 Mbps and attaches the policy map called dts-interface-all-action to pos1/0/0:

```
policy-map dts-interface-all-action
  class class-interface-all
     shape average 10000000

       interface pos1/0/0
          service-policy output dts-interface-all-action
```

Related Commands

Command	Description
shape adaptive	Causes the traffic shaping feature to recognize BECN signals from the Frame Relay network and adjust its shape rate as a result.
shape fecn-adapt	Configures a Frame Relay PVC[1] to reflect received FECN bits as BECN in Q.922 TEST RESPONSE message.

1. permanent virtual circuit

shape adaptive

Use the **shape adaptive** command to configure a Frame Relay interface or a point-to-point subinterface to estimate the available bandwidth by BECN integration while traffic shaping is enabled. If traffic shaping is not enabled, this command has no effect. The **no** form of this command no longer estimates the available bit rate.

shape adaptive *mean-rate-lower-bound*

no shape adaptive

Syntax Description

mean-rate-lower-bound	To react to Frame Relay BECN the lower bound of the range of bit rates that is permitted.

Defaults

No default behavior or values.

Command Modes

Policy map class configuration

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.1(5)T	This command became available for Cisco IOS Release 12.1 T.

Usage Guidelines

When continuous BECN messages are received, the shape entity immediately decreases its maximum shape rate by 1/4 for each BECN message received until it reaches the lower bound CIR. If, after several intervals, the interface has not received another BECN and there is traffic waiting in the shape queue, it increases back to the maximum rate by 1/16 for each interval. A shape entity with “shape adaptive <lower CIR>” configured will always be shaped between the mean rate upper bound and the mean rate lower bound.

Examples

The following example configures a shape entity with CIR 128 Kbps and sets the lower bound CIR to 64 Kbps when BECN is received:

```
policy-map dts-p2p-all-action
  class class-p2p-all
    shape average 128000
    shape adaptive 64000
```

shape fecn-adapt

Use the **shape fecn-adapt configuration** command to configure a Frame Relay interface to reflect received FECN bits as BECN in Q.922 TEST RESPONSE messages. The **no** form of this command configures the Frame Relay to no longer reflect FECN as BECN.

shape fecn-adapt

no shape fecn-adapt

Syntax Description

None

Defaults

No default behavior or values.

Command Modes

Policy-map class configuration

Usage Guidelines

When the downstream Frame Relay switch is congested, a Frame Relay interface or point-to-point interface receives a Frame Relay message with FECN bit on. This may be an indication that there is no traffic waiting to carry a BECN to the far end (voice/multimedia traffic is one-way). When **shape fecn-adapt** is configured a small buffer is allocated, and a Frame Relay Test Response is built on behalf of the Frame Relay switch. The Frame Relay Test Response is equipped with the triggering message's data-link connection identifier (DLCI). It also sets the BECN bit and sends it out to the wire.

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.1(5)T	This command became available for Cisco IOS Release 12.1 T.

Examples

The following example configures a shape entity with CIR 1 Mbps and adapts the Frame Relay message with FECN to BECN:

```
policy-map dts-p2p-all-action
  class class-p2p-all
    shape average 1000000
    shape fecn-adapt
```

Related Commands

Command	Description
shape	Configures an interface to shape traffic to an indicated bit rate.
shape adaptive	Configures a Frame Relay PVC to estimate the available bandwidth by BECN integration while traffic shaping is enabled.

show interfaces shape

Use the **show interfaces shape** EXEC command, to display information about traffic shaping for an interface.

show interfaces [*interface-type interface-number*] **shape**

Syntax Description

interface-type	(Optional) The name of the interface.
interface-number	(Optional) The number of the interface.

Defaults

No default behavior or values.

Command Modes

EXEC

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.1(5)T	This command became available for Cisco IOS Release 12.1 T.

Examples

The following example shows traffic shaping data:

```
POS1/0/0 nobuffer drop 0
POS1/0/0(class 2):
    cir 140000000,  Bc 4480000,  Be 0
    packets output 15926185, bytes output 6578M
    queue limit 10000, queue size 9987, drops 2292096
    last clear = 00:06:16 ago,  shape rate = 139499000 bps

Fddi4/0/0 nobuffer drop 0
Fddi4/0/0(class 20):
    cir 64000,  Bc 8192,  Be 0
    packets output 0, bytes output 0
    queue limit 0, queue size 0, drops 0
    last clear = 00:03:51 ago,  shape rate = 0 bps

Serial6/1/0 nobuffer drop 0
Serial6/1/0.1(class 2):
    cir 128000,  Bc 8192,  Be 0
    lower bound cir 0,  adapt to fecn 0
    packets output 0, bytes output 0
    queue limit 0, queue size 0, drops 0
    last clear = 00:01:15 ago,  shape rate = 0 bps
```

Table 2 show interfaces shape Command Display Information

Field	Description
nobuffers	Number of packet drops due to no available buffer
POS1/0/0, Fddi4/0/0, Ethernet6/0/4, etc.	Interface/sub-interface name
(class 10),(class 20), etc.	Class ID
cir	Mean rate being shaped (bps)
Bc	Sustained burst size (in bits)
Be	Excess burst size (in bits)
lower bound cir	Mean rate lower bound (if the encapsulation is Frame Relay)
adapt to fecn	Adapt to FECN message (if the encapsulation is Frame Relay)
packets output	Number of packets sent out from this shape entity
bytes output	Number of bytes sent out from this shape entity
queue limit	Shape queue limit
queue size	Current shape queue size
drops	Number of packet drops due to full shape queue
last clear	Time difference since last “clear counters” issued
shape rate	Bits output divided by the time difference since last “clear counter” issued (in bps)

Examples

The following example shows the currently configured policy maps:

```
router(config) # show policy-map
 Policy Map dts-p2p-all-action
  class-p2p-all
   shape average 1000000 32000 0

 Policy Map dts-p2p-class-action
  class3
   shape average 800000 51200 0
   shape fecn-adapt

  class4
   shape average 1600000 51200 0
   shape adaptive 800000

 Policy Map dts-interface-all-action
  class-interface-all
   shape average 10000000 320000 0

 Policy Map dts-interface-class-action
  class1
   shape average 16000000 512000 0

  class2
   shape average 8000000 256000 0
```

Related Commands

Command	Description
policy-map	Specifies a policy map to be assigned to an interface.

Glossary

- **ACL**—access control list
- **Bc**—committed Burst
- **Be**—excess Burst
- **BECN**—backwards explicit congestion notification.
- **CIR**—command Information Rate
- **DSCP**—differentiated services code point
- **FECN**—forward explicit congestion notification.
- **QoS group**—A packet label internal to the router that identifies the packet as belonging to a user defined group. A QoS group label can be assigned to a packet using multiple features, including QPPB, CAR, and **set qos-group** *qos-group number*.

Appendix

Traffic Shaping Configuration Comparisons

This section provides a comparison between the distributed Traffic Shaping (DTS), Frame Relay Traffic Shaping (FRTS), and Generic Traffic Shaping (GTS) configurations. For more information on DTS Configuration Commands refer to the "Command Reference" section on page 9.

To shape all traffic on an interface, subinterface, or PVC use the configurations in the following table:

Feature	Configuration
GTS	Router(config)# **interface hssi 3/0/0.1 point-to-point** Router(config-if)# **traffic-shape rate** *CIR*[1] [*Bc*[*Be*]]
FRTS	Router(config)# **map-class frame-relay** *slow_vc*[2] Router(config-cmap)# **frame-relay traffic-rate** *CIR* [*CIR+EIR*][3] Router(config)# **interface hssi 3/0/0** Router(config-if)# **frame-relay traffic-shaping** Router(config)# **interface hssi 3/0/0.1 point-to-point** Router(config-if)# **class** *slow_vc*
DTS	Router(config)# **class-map** *all-traffic*[4] Router(config-cmap)# **match any** Router(config)# **policy-map** *shape-all-traffic*[5] Router(config-pmap)# **class** *all-traffic*[6] Router(config-pmap-c)# **shape** <***average*** | ***peak***>[7] *CIR* [*Bc* [*Be*]] Router(config)# **interface hssi 3/0/0.1** Router(config-if)# **service-policy output** *shape-all-traffic*

1. CIR=Bc bits per second (bps)
2. map-class-name
3. CIR+EIR=(Bc+Be) bps
4. class-name
5. policy-name
6. class-name
7. <*average*>=Bc bps <*peak*>=(Bc+Be) bps

To shape a specific class of traffic on an interface use the configurations in the following table:

:

Feature	Configuration
GTS	Router(config)# **access-list** *10* **permit** *{type-code wild-mask|address mask}* Router(config)# **access-list** *20* **permit** *{type-code wild-mask|address mask}* Router(config)# **interface hssi 3/0/0.1 point-to-point** Router(config-if)# **traffic-shape group** *10 CIR* [*Bc*[*Be*]] Router(config-if)# **traffic-shape group** *20 CIR* [*Bc*[*Be*]]
FRTS	Router(config)# **access-list** *10 {type-code wild-mask|address mask}* Router(config)# **queue-list** *1* **protocol** *ip* [1] *list*[2] *10*[3] Router(config)# **priority-list** *2* **protocol** *ip* **high** Router(config)# **map-class frame-relay** *slow_vc*[4] Router(config-cmap)# **frame-relay custom-queue list** *1* Router(config-cmap)# **frame-relay traffic-rate** *CIR*[*CIR+EIR*] Router(config)# **map-class frame-relay** *fast_vc*[5] Router(config-cmap)# **frame-relay priority-group** 2 Router(config-cmap)# **frame-relay traffic-rate** CIR [CIR+EIR] Router(config)# **interface hssi 3/0/0** Router(config-if)# **frame-relay traffic-shaping** Router(config)# **interface hssi 3/0/0.1 point-to-point** Router(config-if)# **class** *slow_vc* Router(config)# **interface hssi 3/0/0.2 point-to-point** Router(config-if)# **class** *fast_vc*
DTS	Router(config)# **access-list** 10 **permit***{type-code wild-mask|address mask}* Router(config)# **access-list** 20 **permit***{type-code wild-mask|address mask}* Router(config)# **class-map** *class 1* Router(config-cmap)# **match access-group** *10*[6] Router(config)# **class-map** *class 2* Router(config-cmap)# **match access-group** *20* Router(config)# **policy-map** ***shape-class-1-and-2*** Router(config-pmap)# **class** ***class 1*** Router(config-pmap-c)# **shape** *<average|peak> CIR*[*Bc*[*Be*]] Router(config-pmap)# **class** *class 2* Router(config-pmap-c)# **shape** *<average|peak> CIR*[*Bc*[*Be*]] Router(config)# **interface hssi 3/0/0.1 point-to-point** Router(config-if)# **service-policy output** *shape-class-1-and-2*

1. queue-number
2. queue-keyword
3. keyword-value
4. map-class-name
5. map-class-name
6. access-group