



Any Transport over MPLS (AToM): Layer 2 QoS (Quality of Service)

This document describes MPLS Quality of Service (QoS) implementations for Cisco 12000 Series line cards configured for Frame Relay over MPLS (FRoMPLS), ATM over MPLS (ATMoMPLS), and Ethernet over MPLS (EoMPLS). Local Switching features are noted but not discussed in this document.

Feature History for Any Transport over MPLS (AToM): Layer 2 QoS (Quality of Service)

| Release | Modification |
|-----------|--|
| 12.0(30)S | These features were introduced on the Cisco 12000 series routers and line cards. |
| 12.0(32)S | Support for these features on the Engine 5 line card was added, as well as per-DLCI egress shaping within Frame Relay over MPLS, and two-rate three-color color-aware policing for Ethernet VLANs. |

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

- [Information About Any Transport over MPLS \(AToM\): Layer 2 QoS \(Quality of Service\), page 2](#)
- [How to Configure MDRR and WRED, page 6](#)
- [How to Configure Traffic Policing and Shaping for Frame Relay over MPLS, page 7](#)
- [How to Configure ATMoMPLS Traffic Policing, page 16](#)
- [How to Configure ATMoMPLS Traffic Shaping, page 20](#)
- [How to Configure Traffic Policing and Shaping for EoMPLS, page 23](#)



Corporate Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Copyright © 2006 Cisco Systems, Inc. All rights reserved.

- [Additional Configuration Examples for Any Transport over MPLS \(AToM\): Layer 2 QoS \(Quality of Service\)](#), page 30
- [Additional References](#), page 31

Information About Any Transport over MPLS (AToM): Layer 2 QoS (Quality of Service)

Policing and shaping Layer 2 VPN traffic at the MPLS imposition and disposition interfaces permits the Service Provider to offer service level agreements (SLAs) to customers in terms that include bandwidth, delay, jitter, and packet-loss guarantees. At imposition, Frame Relay, Asynchronous Transfer Mode, or Ethernet QoS markers are mapped to MPLS experimental bits. The traffic can be classified by the MPLS experimental bit, then policed and shaped on the provider interfaces. For traffic traversing the Cisco 12000 Series Router, Modified Deficit Round Robin (MDRR) congestion management and Weighted Random Early Detection (WRED) congestion avoidance are now supported for MPLS packets with Layer 2 VPN payloads. Because packet queuing characteristics vary among the Cisco 12000 Series line cards, MDRR and WRED configurations can vary with the line card combinations used for MPLS imposition and disposition interfaces. [Table 1](#) displays a summary of the Layer 2 QoS features introduced in Cisco Release 12.0(32)S, as well as those supported in previous Cisco IOS releases.

Layer 2 QoS features supported by the Cisco 12000 Series router and line cards for Cisco IOS Release 12.0(32)S are as follows:

For All Transport Types:

- Per-class traffic shaping on egress (disposition) for all Cisco 12000 Series line cards
- Per-class traffic shaping on ingress (imposition) for all Cisco 12000 Series line cards

Frame Relay Features

- Support of Two-rate, Three-color policer for Cisco 12000 Series ISE Packet-over-SONET line cards, based on RFC-2698.
- Support for marking MPLS experimental bits (EXP) as a policing action, in addition to setting the discard eligibility (DE) bits
- Mapping and copying of Layer 2 Class of Service (CoS) DE bits to MPLS experimental bits at the ingress
- Per-DLCI egress shaping on Engine 5

ATM Features

- Support of AAL5 policing in Cisco 12000 Series ISE ATM line cards, based on the Generic Cell Rate Algorithm (GCRA) policer in the ATM Traffic Management Specification Version 4.1 (TM 4.1)
- Support of Two-rate, Three-color policer for Cisco 12000 Series ATM line cards based on GCRA for ATM and RFC-2698.
- Support for marking MPLS experimental bits as a policing action, in addition to setting Cell Loss Priority bits
- Mapping and copying of Layer 2 Class of Service (CoS) Cell Loss Priority (CLP) bits to MPLS experimental bits at the ingress for all Cisco 12000 Series ATM line cards

- Filtering and classification of control traffic for ATM line cards with match OAM command to permit OAM cells that are in sequence to be excluded from classification
- Per-VC shaping for all Cisco 12000 Series ATM line cards
- Support for the CLP thresholds (0/1) discard mechanism on Cisco 12000 Series ISE ATM line cards.

Ethernet Features

- Support of Two-rate, Three-color policer for Cisco 12000 Series ISE Ethernet line cards, including VLANs, based on RFC-2698.
- Support for marking MPLS experimental bits as a policing action, in addition to setting the 802.1p User Priority field (P-bits)
- Mapping and copying of the Layer 2 class of service (COS) P-bits to MPLS experimental bits at the ingress
- Mapping and copying of MPLS experimental bits to Layer 2 CoS P-bits at the egress.
- Setting of Layer 2 CoS P-bits based on the VLAN ID at egress
- Egress traffic shaping on all line cards.

HDLC/PPP Features

- Exp marking

Miscellaneous Features

- Support for MDRR/WRED (tofab and frfab) for MPLS packets with Layer 2 Virtual Private Network (L2VPN) payloads
- Support for the **set-qos-group** and **set-discard-class** policer action options for the Cisco 12000 Series line cards based on Engine 3 and Engine 5.
- Support for class-based QoS MQC MIBS relating to MPLS-based Layer 2 VPNs.

Table 1 MPLS and Local Switching Quality of Service Command Summary for Cisco IOS Release 12.0(32)S

| Feature | Frame Relay over MPLS & LS | | | | ATM over MPLS & LS | | | | Ethernet over MPLS & LS | | | | |
|--|----------------------------|---------|-------------|---------|--------------------|---------|-------------|---------|-------------------------|---------|-------------|---------|--|
| | Imposition | | Disposition | | Imposition | | Disposition | | Imposition | | Disposition | | |
| | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | |
| 30S+=supported in 30S & afterwards X=not supported in 30S or 32S LSW=in 30S & 32S local switching only | | | | | | | | | | | | | |
| Traffic Classification Options—class map | | | | | | | | | | | | | |
| match any | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | pre-30S | |
| match fr-de | 30S+ | n/a | n/a | n/a | — | — | — | — | — | — | — | — | |
| match atm clp | — | — | — | — | 30S+ | n/a | n/a | n/a | — | — | — | — | |
| match atm oam-cell | — | — | — | — | 30S+ | n/a | n/a | n/a | — | — | — | — | |
| match qos-group <i>qos-group-value</i> | n/a | LSW | n/a | 30S+ | n/a | LSW | n/a | 30S+ | n/a | LSW | n/a | 30S+ | |
| match cos <i>cos_value</i> | — | — | — | — | — | — | — | — | pre-30S | — | n/a | n/a | |
| match mpls experimental <i>exp-value</i> | n/a | 30S+ | 30S+ | n/a | n/a | 30S+ | 30S+ | n/a | n/a | 30S+ | 30S+ | n/a | |
| match vlan <i>vlan-id</i> | — | — | — | — | — | — | — | — | 30S+ | n/a | n/a | n/a | |
| map -class frame-relay <i>map-class-name</i> | 30S+ | — | — | 32S | — | — | — | — | — | — | — | — | |
| Policers | | | | | | | | | | | | | |
| Percent CIR and PIR | 30S+ | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | |
| Percent TM4.0 (ms bc/be) | — | — | — | — | 30S+ | n/a | n/a | n/a | — | — | — | — | |
| Policer Options | | | | | | | | | | | | | |
| 1-rate, 2-color | X | n/a | n/a | n/a | X | n/a | n/a | n/a | pre-30S | n/a | n/a | 31S | |
| 2-rate, 3-color; color-blind | pre-30S | n/a | n/a | n/a | X | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | |
| 2-rate, 3-color; color-aware | 30S+ | n/a | n/a | n/a | X | n/a | n/a | n/a | 32S | n/a | n/a | n/a | |
| TM4.0 (SAR-based) | — | — | — | — | 30S+ | n/a | n/a | n/a | — | — | — | — | |
| conform-action transmit | pre-30S | X | X | X | pre-30S | X | X | X | pre-30S | X | X | X | |
| conform-action set-mpls-exp-imposition-transmit <i>exp-value</i> | 30S+ | X | X | X | 30S+ | X | X | X | 30S+ | X | X | X | |
| exceed-action transmit | 30S+ | X | X | X | 30S+ | X | X | X | 30S+ | X | X | X | |
| exceed-action drop | 30S+ | X | X | X | 30S+ | X | X | X | 30S+ | X | X | 31S | |
| exceed-action set-mpls-exp-imposition-transmit <i>exp-value</i> | 30S+ | X | X | X | 30S+ | X | X | X | 30S+ | X | X | X | |
| exceed-action set-frde-transmit | 30S+ | X | X | X | — | — | — | — | — | — | — | — | |

Table 1 MPLS and Local Switching Quality of Service Command Summary for Cisco IOS Release 12.0(32)S

| Feature | Frame Relay over MPLS & LS | | | | ATM over MPLS & LS | | | | Ethernet over MPLS & LS | | | | |
|--|----------------------------|-----|-------------|-----|--------------------|-----|-------------|-----|-------------------------|-----|-------------|-----|--|
| | Imposition | | Disposition | | Imposition | | Disposition | | Imposition | | Disposition | | |
| | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | |
| 30S+ =supported in 30S & afterwards X =not supported in 30S or 32S LSW =in 30S & 32S local switching only | | | | | | | | | | | | | |
| exceed-action set-clp-transmit * n/a for AAL5oMPLS | — | — | — | — | 30S+ | X | X | X | — | — | — | — | |
| exceed-action set-qos-group-transmit <i>qos-group-value</i> | LSW | X | X | X | LSW | X | X | X | LSW | X | X | X | |
| exceed-action set-discard-class-transmit <i>discard-class-value</i> | LSW | X | X | X | LSW | X | X | X | LSW | X | X | X | |
| exceed-action set-qos-group-transmit <i>value</i> and set-discard-class-transmit <i>value</i> | LSW | X | X | X | LSW | X | X | X | LSW | X | X | X | |
| exceed-action set-mpls-exp-imposition <i>exp</i> and set-frde-transmit | 30S+ | X | X | X | — | — | — | — | — | — | — | — | |
| exceed-action set-mpls-exp-imposition <i>exp</i> and set-clp-transmit | — | — | — | — | 30S+ | X | X | X | — | — | — | — | |
| violate-action drop | pre-30S | X | X | X | pre-30S | X | X | X | pre-30S | X | X | X | |

Traffic Shaping Options

| | | | | | | | | | | | | |
|---|-----|-----|------|------|-----|-----|------|------|------|-----|------|------|
| Per-VC Egress (Disposition) Shaping | n/a | n/a | n/a | 32S | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | 30S+ |
| Per-VC Ingress (Imposition) Shaping | X | n/a | n/a | n/a | X | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a |
| Per-Class Egress (Disposition) Shaping | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a | 30S+ |
| Per-Class Ingress (Imposition) Shaping | X | n/a | n/a | n/a | X | n/a | n/a | n/a | 30S+ | n/a | n/a | n/a |
| set mpls experimental [topmost imposition] {exp-value} (topmost not supported for AToM) | LSW | n/a | n/a | n/a | LSW | n/a | n/a | n/a | LSW | n/a | n/a | n/a |
| set cos <i>cos-value</i> (802.1p bits) | — | — | — | — | — | — | — | — | n/a | n/a | n/a | 30S+ |
| set qos-group <i>qos-group-value</i> | LSW | X | 30S+ | X | LSW | X | 30S+ | X | LSW | X | 30S+ | X |
| set discard-class <i>discard-class-value</i> | LSW | X | 30S+ | X | LSW | X | 30S+ | X | LSW | X | 30S+ | X |

Table 1 MPLS and Local Switching Quality of Service Command Summary for Cisco IOS Release 12.0(32)S

| Feature | Frame Relay over MPLS & LS | | | | ATM over MPLS & LS | | | | Ethernet over MPLS & LS | | | | |
|--|----------------------------|------|-------------|------|--------------------|------|-------------|------|-------------------------|------|-------------|------|-----|
| | Imposition | | Disposition | | Imposition | | Disposition | | Imposition | | Disposition | | |
| | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT | |
| 30S+ =supported in 30S & afterwards X =not supported in 30S or 32S LSW =in 30S & 32S local switching only | | | | | | | | | | | | | |
| bandwidth { <i>bw-value</i> [<i>percent</i> <i>remaining</i>] <i>percentage</i> > } | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | |
| shape { [<i>max buffer-limit</i>] [<i>peak</i> <i>average</i>] <i>target-bit-rate</i> } | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | |
| priority | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | |
| queue-limit <i>num-of-cells-or-pkts</i> | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | |
| random-detect discard-class <i>value min-thr max-thr prob-den</i> | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | X | 30S+ | |
| random-detect precedence <i>value min-thr max-thr prob-den</i> (precedence=mpls-exp) | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | 30S+ | |
| Miscellaneous Features | | | | | | | | | | | | | |
| Filtering on BPDU (drop or rate-limit, also other types of traffic) | — | — | — | — | — | — | — | — | — | 30S+ | n/a | n/a | n/a |

How to Configure MDRR and WRED

For configuration overview information on MDRR for the Cisco 12000 Series line cards, see *Understanding and Configuring MDRR/WRED on the Cisco 12000 Series Internet Router* at the following URL:

http://www.cisco.com/warp/public/63/mdrr_wred_overview.html

For WRED legacy CLI configuration information, examples, and command descriptions, see *Weighted Random Early Detection on the Cisco 12000 Series Router* at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios112/ios112p/gsr/wred_gs.htm

On the ToFab (Rx) side of the Cisco 12000 Series routers, you must use the legacy QoS CLI and the Modular Quality of Service CLI (MQC) configuration on the FrFab (Tx) side. The QoS policy for ToFab or the FrFab side can be applied on imposition and disposition routers.

On the ToFab side, the QoS policy is constructed based on the MPLS experimental bits. The keyword **precedence** implies EXP bits for MPLS packets, which covers AToM packets as well on the imposition Rx card. The correct output queue (OQ) or local output queue (LOQ) value is selected and a different WRED profile is applied based on the experimental bit settings.

On the FrFab side for imposition, QoS policy can be constructed using MQC to match on EXP bits. On the FrFab side for disposition, EXP value is conveyed to the Tx line card by the qos-group ID/discard-class and QoS policy can be constructed using MQC to match on qos-group ID bits to select the OQ/LOQ and discard-class to select WRED profile. This functionality is used to achieve egress shaping on EXP values. The QoS policy is created on a source-slot/destination-slot table basis.

Configuring WDRR and WRED with the Legacy CLI Configuration: Example

```

rx-cos-slot 0 slot0
slot-table-cos slot0
  destination-slot 1 slot0-to-slot1
cos-queue-group slot0-to-slot1
  precedence 0 queue low-latency
  precedence 1 queue 1
  precedence 1 random-detect-label 1
  precedence 2 queue 2
  precedence 2 random-detect-label 2
  precedence 3 queue 3
  precedence 3 random-detect-label 3
  random-detect-label 1 100 200 1
  random-detect-label 2 200 300 1
  random-detect-label 3 300 400 1
  queue 0 20
  queue 1 20
  queue 2 30
  queue 3 30
  queue low-latency strict-priority

```

How to Configure Traffic Policing and Shaping for Frame Relay over MPLS

Configuring FRoMPLS Two-rate Three-color Policer

Table 2 displays the FRoMPLS policer options supported in Release 12.0(32)S.

See *Cisco IOS Quality of Service Solutions Command Reference, Release 12.3* at the following URL for further information on police policy-map configuration commands:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123cgcr/qos_r/index.htm

Table 2 FRoMPLS Policer Commands for Layer 2 VPN in Cisco IOS Release 12.0(32)S

| Supported Policer Commands, Options, or Actions | Details |
|---|--|
| police cir percent <i>percentage</i> [<i>burst-in-ms</i>] [bc conform-burst-in-msec ms] [be peak-burst-in-msec ms] [pir percent percent] | Configures traffic policing on the basis of the specified bandwidth percentage and optional burst sizes. Percentage-based policing and shaping is supported as in Cisco IOS Release 12.0(28)S. |
| police { cir <i>cir</i> } [bc conform-burst] { pir <i>pir</i> } [be peak-burst] [conform-action <i>action</i>] [exceed-action <i>action</i>] [violate-action <i>action</i>] | Two-rate traffic policer policy-map configuration command. |
| exceed-action drop | This option causes the router to discard packets that are received at a rate exceeding the committed information rate and less than or equal to the peak information rate (PIR). |

Table 2 FRoMPLS Policer Commands for Layer 2 VPN in Cisco IOS Release 12.0(32)S

| Supported Policer Commands, Options, or Actions | Details |
|---|--|
| exceed-action transmit | This option causes the router to transmit packets that are received at a rate exceeding the committed information rate and less than or equal to the peak information rate (PIR). |
| set-mpls-exp-transmit <i>value</i> | This action is a conform-action and exceed-action option for the Two-rate Three-color policer. The set-mpls-exp-transmit option sets the Multiprotocol Label Switching (MPLS) experimental bits from 0 to 7 and sends the packet with the new MPLS experimental bit value setting. This option can be used with set-frde-transmit in multiple action mode. |
| set-frde-transmit | This action is a conform-action and exceed-action option for the Two-rate Three-color policer. The set-frde-transmit policing action option sets the Frame Relay discard eligible (DE) bit from 0 to 1 on the Frame Relay frame then transmits that packet. In congested environments, frames with the DE bit set to 1 are discarded before frames with the DE bit set to 0. This option can be used with set-mpls-exp-transmit in multiple action mode. |
| violate-action drop | Causes the router to discard packets that are received at a rate exceeding the peak information rate (PIR). |

Cisco IOS 12.0(30)S introduced support for the following Two-rate, Three-color policer in color-aware mode for FRoMPLS, with matching on Frame Relay discard eligible bit (**match fr-de**) as a color:

```
police {cir cir} [bc conform-burst] {pir pir} [be peak-burst] [conform-action action [exceed-action action] [violate-action action]]]
```

The **set-frde-transmit** and **set-mpls-exp-transmit** *value* options can be used in multiple action mode.

The color-blind version of the Three-color policer was supported for Layer 2 VPNs in earlier Cisco IOS releases.

For further information on Two-rate, Three-color policers see *QoS: Color-Aware Policer* at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s26/12s_cap.htm

For further information on multiple actions policing, see *Policer Enhancement — Multiple Actions* at the following URL:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t8/ftpolenh.htm>

Restrictions

Two-rate three-color color-blind policer is supported on Cisco 12000 Series line card with Engines 0, 2, 3 or 5 (ISE). Two-rate three-color color-aware policer is supported on Cisco 12000 Series line card with Engines 3 or 5 (ISE).

Two-rate Three-color Color-blind Policer: Example

The following color-blind configuration fragment sets the DE bit to 1 for packets in flows that exceed the committed information rate (CIR) but are less than or equal to the peak information rate (PIR). Packets in flows that exceed the PIR are discarded:

```
Router(config-pmap-c)# police cir 64000 bc 10000 pir 128000 be 20000 conform-action
transmit exceed-action set-frde-transmit violate drop
```

Two-rate Three-color Color-blind Policer with Multiple Actions: Example

The following color-blind, multi-action configuration example sets the DE bit to 1 and the MPLS experimental value to 5 for packets in flows that exceed the committed information rate (CIR) but are less than or equal to the peak information rate (PIR). Packets in flows that exceed the PIR are discarded:

```
Router(config-pmap-c)# Police cir 64000 pir 128000
Router(config-pmap-c-police)# conform-action transmit
Router(config-pmap-c-police)# exceed-action set-mpls-exp-transmit 5
Router(config-pmap-c-police)# exceed-action set-frde-transmit
Router(config-pmap-c-police)# violate-action drop
```

Two-rate Three-color Color-aware Policer with Multiple Actions: Example

The following color-aware configuration fragment demonstrates the use of the discard eligibility bit as a color:

```
Router(config)# class-map frde_class
Router(config-cmap)# match fr-de

Router(config)# class-map no_frde_class
Router(config-cmap)# match not fr-de

Router (config)# policy-map color-aware-fr
Router(config-pmap)# class kulur-awhere
Router(config-pmap-c)# police cir 64000 bc 10000 pir 128000 be 20000
Router(config-pmap-c-police)# conform-color no_frde_class exceed-color
frde_class
Router(config-pmap-c-police)# conform-action transmit
Router(config-pmap-c-police)# exceed-action set-frde-transmit
Router(config-pmap-c-police)# violate-action drop
```

Configuring FRoMPLS Traffic Shaping

In general Frame Relay allows two types of traffic shaping: Generic Traffic Shaping (GTS) and Frame-relay Traffic Shaping (FRTS). For FRoMPLS, GTS per-class disposition shaping and per-class imposition shaping are supported. Beginning with Engine 5, per-DLCI egress shaping also is supported.

The following sections on traffic shaping relate only to Cisco 12000 Series ISE line cards (Engine 3 and Engine 5):

- [Configuring FRoMPLS Per-VC Disposition Shaping, page 11](#)
- [Configuring FRoMPLS Per-class Disposition Shaping, page 13](#)
- [Configuring FRoMPLS Per-VC Imposition Shaping, page 13](#)
- [Configuring FRoMPLS Per-Class Imposition Shaping, page 13](#)
- [Configuring FRoMPLS Per-DLCI Egress Shaping, page 13](#)

Table 3 lists the FRoMPLS policy-map configuration commands supported in Cisco IOS Release 12.0(32)S.

**Note**

For per-DLCI egress shaping the only supported instructions are **match any**, **class-default**, **shape**, **queue-limit**, and **random-detect discard-class**.

Table 3 FRoMPLS Map, Set, and WRED MQC Commands

| Supported Policy Map Configuration Command | Details |
|--|---|
| match any | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| match fr-de | The match fr-de packet classification option, when specified in a class map, matches packets that have the Frame Relay DE bit set to 1. |
| match mpls experimental <i>exp-value</i> | Configure a class map to use the specified value of the EXP field as a match criterion. |
| match qos-group <i>qos-group-value</i> | Identifies a specific QoS group value marking on a packet. This command can also be used to convey the received Multiprotocol Label Switching (MPLS) experimental (EXP) field value to the output interface. |
| set mpls experimental imposition <i>exp-value</i> | Designates the value to which the MPLS bits are set if the packets match the specified policy map. |
| set qos-group <i>group-id</i> | <p>The set qos-group command allows you to associate a group ID with a packet. The group ID can be used later to classify packets into QoS groups based as prefix, autonomous system, and community string. This action marks a packet on the Rx card so that Tx features such as policing and shaping can be applied to the matching packets on the Tx card.</p> <p>The treatment of packets in a qos-group is defined through the configuration of QoS policies in policy-map class configuration mode. The <i>qos-group-value</i> is simply a group identifier, and does not indicate precedence or classification in itself.</p> <p>The <i>qos-group-value</i> is local to the router and is removed on egress from the router.</p> |
| set discard-class | Use this command to specify the type of traffic to be dropped when there is congestion. There is no corresponding match action for discard-class for Cisco 12000 Series line cards. This command marks a packet on the RX card so that WRED can be applied on the TX card. |

Table 3 FRoMPLS Map, Set, and WRED MQC Commands

| Supported Policy Map Configuration Command | Details |
|--|--|
| bandwidth { <i>bw-value</i> [[percent remaining] percentage >] } | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S, but not supported in per-DLCI egress shaping. |
| priority | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| queue-limit <i>num-of-cells-or-pkts</i> | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S, and on per-DLCI egress shaping in 12.0(32)S. |
| random-detect discard-class <i>value min-thr max-thr prob-den</i> | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S, and on per-DLCI egress shaping in 12.0(32)S. |
| random-detect precedence <i>value min-thr max-thr prob-den</i> (precedence=mpls-exp) | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| shape { [max <i>buffer-limit</i>] [[peak average] <i>target-bit-rate</i>] } | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S, and on per-DLCI egress shaping in 12.0(32)S. |

For further information on QoS commands, See *Cisco IOS Quality of Service Solutions Command Reference, Release 12.3* at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123cgcr/qos_r/index.htm

Configuring FRoMPLS Per-VC Disposition Shaping

On Engine 5 line cards, output policy is attached to the FR interface or sub-interface using the **map-class** command. (The **switched-dlci** method, used in releases before 12.0(32)S, has now been retired). The **switched-dlci** method is also not supported on the SIP-400 linecard with SPA-4XcT3/DS0 running release 12.0(31)S2.

The commands allowed are **match-any** and **class-default**.

The actions allowed are **share**, **queue-limit**, and **random detect discard-class**.

The following table shows how to configure per-dlci egress shaping.

| | Command or Action | Purpose |
|--------|--|---|
| Step 1 | enable Example: Router> enable | Enables privileged EXEC mode. <ul style="list-style-type: none">Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |

How to Configure Traffic Policing and Shaping for Frame Relay over MPLS

| | Command or Action | Purpose |
|---------|---|---|
| Step 3 | policy-map <i>policy-map-name</i> Example: Router(config)# policy-map shaper_16kbps | Creates the name of a traffic policy map, and opens policy map configuration mode. |
| Step 4 | class { <i>class-name</i> class-default } Example: Router(config-pmap)# class class-default | Creates the name of a traffic class (or the default class) whose policy will be specified, and opens policy-map class configuration mode. |
| Step 5 | shape [average peak] <i>mean-rate</i> [[<i>burst-size</i>] [<i>excess-burst-size</i>]] Example: Router(config-pmap-c)# shape average 16000 | Shapes the traffic in that class to the indicated bit rate. This will become the egress traffic's behavior when the remaining steps in this table have been entered. Alternative available actions are queue-limit and random detect discard-class . |
| Step 6 | exit Router(config-pmap-c)# exit | Exits policy-map class configuration mode. |
| Step 7 | exit Router(config-pmap)# exit | Exits policy map configuration mode. |
| Step 8 | map-class frame-relay <i>map-class-name</i> Example: Router(config)# map-class frame-relay fr_100 | Creates the name of a map class, and opens map-class configuration mode. |
| Step 9 | service-policy { input output } <i>policy-map-name</i> Example: Router(config-mp)# service-policy output shaper_16kbps | Associates the policy map created in Step 3 with a single direction of traffic (in this example, egress), and with the just-named map class. |
| Step 10 | interface <i>interface-name</i> Example: Router(config)# interface p0/0 | Enters interface configuration mode for the interface whose egress traffic is to be governed by the policy. |
| Step 11 | frame-relay interface-dlci <i>dlci</i> switched Example: Router(config-if)# frame-relay interface-dlci 100 switched | Opens Frame Relay DLCI interface configuration mode for the SVC that carries the output traffic. |
| Step 12 | class <i>map-class-name</i> Example: Router(config-fr-dlci)# class fr_100 | Attaches the traffic-shaping policy to this particular SVC (DLCI). |

Configuring FRoMPLS Per-class Disposition Shaping

For FRoMPLS per-class disposition traffic shaping, match on the MPLS experimental value on the ingress disposition card then set the **qos-group** and the **discard-class** (if necessary).

On the egress port on the disposition router, match and shape on the class represented by the **qos-group**. WRED can be applied on **discard-class** values.

The policy is attached in the output direction on the customer-facing main interface.

The following procedure demonstrates the steps recommended to configure FRoMPLS per-class disposition shaping:

Step 1 Define the classes for matching the MPLS experimental values.

```
class-map match-any exp1
  match mpls exp 1

class-map match-any exp2
  match mpls exp 2
```

Step 2 Define the ingress policy to be applied to the RX interface.

```
policy-map ingress-policy
  class exp1
    set qos-group 1
    set discard-class 1
  class exp2
    set qos-group 2
    set discard-class 2
```

Step 3 Define the classes for matching on **qos-group** on egress.

```
class-map match-all qos1
  match qos-group 1
class-map match-all qos2
  match qos-group 2
```

Step 4 Define the egress policy to be applied to TX interface.

```
Policy-map egress-policy
  Class qos1
    bandwidth percent 10
    shape average 64000000
    random-detect discard-class-based
    random-detect discard-class 1 1000 2000
    random-detect discard-class 2 2000 3000
```

Configuring FRoMPLS Per-VC Imposition Shaping

Per-virtual circuit imposition shaping is not supported for FRoMPLS in Cisco IOS Release 12.0(32)S.

Configuring FRoMPLS Per-Class Imposition Shaping

To configure per-class imposition shaping for FRoMPLS, mark the packets with **set experimental imposition** on the Rx line card, then apply shaping on the Tx line card.

The policy is attached in the output direction on the core-facing interface.

FRoMPLS Per-Class Imposition Shaping: Example

In the following example, the map class labeled `fr_set_exp1` is applied to the Rx interface, and the policy map labeled `imposition_tx_shaping` is applied as shown below to the Tx interface.

```
policy-map set_exp1
  class class-default
    set mpls experimental imposition 1

map-class frame-relay fr_set_exp1
  service-policy input set_exp1

class-map match-all match_exp1
  match mpls experimental 1

policy-map imposition_tx_shaping
  class match_exp1
    shape average 64000 32000
    queue-limit 200 packets

interface POS0/0
  frame-relay interface-dlci 100 switched
  class fr_set_exp1

interface POS1/0
  service-policy output imposition_tx_shaping
```

Configuration Examples for FRoMPLS Traffic Policing and Shaping

- [Attaching a Service Policy to Main Interface: Example, page 14](#)
- [Attaching a Service Policy to Main Interface with Map-class: Example, page 14](#)
- [Attaching a Service Policy to a Subinterface: Example, page 15](#)
- [Frame Relay Customer-facing Interface: Example, page 15](#)
- [Per-DLCI Egress Shaping: Example, page 15](#)

Attaching a Service Policy to Main Interface: Example

```
interface POS0/0
  service-policy input ingress_policy

connect from101 POS0/0 101 12transport
  xconnect 5.5.5.5 101 encapsulation mpls
```

Attaching a Service Policy to Main Interface with Map-class: Example

```
interface POS0/0
  frame-relay interface-dlci 101 switched
  class dlci_101
```

```

map-class frame-relay dlci_101
  service-policy input ingress_policy

connect from101 POS0/0 101 l2transport
  xconnect 5.5.5.5 101 encapsulation mpls

```

Attaching a Service Policy to a Subinterface: Example

```

interface POS0/0.1 point-to-point
  switched-dlci 101
  service-policy input ingress_policy

connect from101 POS0/0 101 l2transport
  xconnect 5.5.5.5 101 encapsulation mpls

```

Frame Relay Customer-facing Interface: Example

```

int p0/0
  frame-relay interface-dlci 100 switched
    class fr_100
  frame-relay interface-dlci 101 switched
    class fr_101
  frame-relay interface-dlci 102 switched
    class fr_102
  service output match-qos-discard
int p0/0.200
  switched-dlci 200
  service input 2R3C_policer_color_blind
int p0/0.201
  switched-dlci 201
  service input 2R3C_policer_color_aware
int p0/0.202
  switched-dlci 202
  service input set_exp_from_frde

map-class frame-relay fr_100
  service input 2R3C_policer_color_blind

map-class frame-relay fr_101
  service input 2R3C_policer_color_aware

map-class frame-relay fr_102
  service input set_exp_from_frde

```

Per-DLCI Egress Shaping: Example

```

policy-map shaper_16Kbps
  class class-default
    shape average 16000

map-class frame-relay fr_100
  service-policy output shaper_16Kbps

int p0/0
  frame-relay interface-dlci 100 switched
    class fr_100

```

How to Configure ATMoMPLS Traffic Policing

ATMoMPLS policing follows the ATM Forum Traffic Management specification version 4.0. The Generic Cell Rate Algorithm (GCRA) policer is implemented for the ATM service category conformances of CBR.1, VBR.1, VBR.2, VBR.3 and UBR.1. The GCRA policing complies with International Telecommunications Union Recommendation I.371. This section discusses AAL5oMPLS only.

Policer actions for AAL5 are like the GCRA implementation, except that the algorithm is cell-based. The following statements describe the policer actions of conform, exceed, and violate in terms of Peak Cell Rate (PCR) and Sustainable Cell Rate (SCR):

- AAL5 Packet is conform: If all the cells in the AAL5 packet passed PCR and SCR bucket checks
- AAL5 Packet is exceed: If at least one cell in the AAL5 packet has failed SCR bucket check
- AAL5 Packet is violate: If at least one cell in the AAL5 packet has failed PCR bucket check

For AAL5 packet exceed, the Martini Control Word “C” bit is set. For AAL5 packet violate, the packet is dropped (if **violate-action drop** is configured). For example, if one cell in the AAL5 packet has violated the GCRA PCR check, the entire AAL5 packet is dropped.

OAM cells are subject to the same policing as user cells, that is, here is no special treatment to OAM cells while policing, if the policy is configured for a class-default class. OAM cells can be exempted from policing, if the policy is configured for a class which has **match not atm oam-cell**. However, all OAM types are treated alike.

Support is extended for **set-mpls-exp-imposition-transmit** and **set-clp-transmit** in conform action and multiple action modes.

ATMoMPLS supports cell-packing with the cell-packing criteria being OAM-based, CLP-based and policer-result based. If the MQC policer configuration contains **set-mpls-exp-imposition-transmit**, then a policer-result based cell-packing is chosen. This allows the MPLS packets with a specific EXP value to be packed into one packet. However OAM cells are still packed separately from the user cells.

Table 4 lists the ATMoMPLS policer commands and options supported in Cisco IOS Release 12.0(32)S.

Table 4 ATMoMPLS Policer MQC Commands and Options

| Supported Commands | Details |
|---|--|
| police cir percent percentage [burst-in-ms] [bc conform-burst-in-msec ms] [be peak-burst-in-msec ms] [pir percent percent] | Configures traffic policing on the basis of the specified bandwidth percentage and optional burst sizes. Percentage-based policing and shaping is supported as in Cisco IOS Release 12.0(28)S. |
| police rate percent percentage [burst burst-in-ms ms] [peak-rate percent percentage] [peak-burst burst-in-ms ms] | Supported as in 12.0(27)S and 12.0(28)S. |
| set-mpls-experimental-imposition-transmit | Sets the value of MPLS exp bits in packets governed by the exceed-action and conform-action option of the police command. This command can be used with the set-atm-clp option in multiple action mode. |

Table 4 **ATMoMPLS Policer MQC Commands and Options**

| Supported Commands | Details |
|---------------------------------------|--|
| exceed-action set-clp-transmit | Sets the Cell Loss Priority bit and transmits ATM cells that meet policer exceed criteria. |
| violate-action drop | Causes the router to discard packets that are received at a rate in excess of the exceed criteria. |

For further information on OAM-based traffic policing and shaping see, *QoS: Match ATM OAM* at the following URL:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s30/gsatmoam.htm>

For further information on the ATM Cell-based Policer, see *QoS: ATM Cell-Based Policer* at the following URL:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s28/fscbp.htm>

For further information on CLP-based traffic policing and shaping see, *QoS: ATM CLP-Based Queue Limit* at the following URL:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s30/12sqatcl.htm>

Configuring ATMoMPLS Policer

- [Constant Bit Rate—CBR.1, page 17](#)
- [Unspecified Bit Rate—UBR.1, page 18](#)
- [Variable Bit Rate —VBR.1, page 18](#)
- [Variable Bit Rate —VBR.2 and VBR.3 Without Cell Tagging, page 18](#)
- [Variable Bit Rate —VBR.3 with Cell Tagging, page 19](#)
- [Policing Configuration Excluding OAM Cells, page 19](#)

Constant Bit Rate—CBR.1

CBR.1 is real-time traffic and only one rate is specified (PCR) to describe a CBR service category. All traffic exceeding the PCR is dropped. Please note that delay-tolerance (CDVT) needs to be specified for CBR conformance. Delay-tolerance is specified in microseconds.

```
policy CBR1
class class-default
    police rate <PCR> cps delay-tolerance <CDVT> us
        conform-action set-mpls-exp-imposition-transmit <EXP value>
        exceed-action drop
```

The same policy can be represented as percentage of the interface rate units, as follows:

```
policy CBR1
class class-default
    police rate <PCR in percent> percent delay-tolerance <CDVT> us
        conform-action set-mpls-exp-imposition-transmit <EXP value>
        exceed-action drop
```

Unspecified Bit Rate—UBR.1

UBR.1 is non-real-time traffic and only one rate is specified (PCR) to describe a UBR service category. All traffic exceeding the PCR is dropped. Please note that delay-tolerate (CDVT) needs to be specified for UBR conformance, but it can much higher compared to the delay-tolerance specified for a CBR connection. Also, note that there is no difference as far as policing is concerned between CBR and UBR service. So the policy-maps remain same. An operator typically sets the EXP value differently between a CBR and UBR service. Delay-tolerance is specified in microseconds.

Variable Bit Rate—VBR.1

VBR.1 is real-time as well as non-real-time traffic and two rates are specified (PCR and SCR) to describe a VBR service category. All traffic exceeding the PCR is dropped. Delay-tolerate (CDVT) must be specified for VBR conformance. Delay-tolerance is specified in microseconds. In addition, **atm-mbs** can also be specified to represent the burst allowed on an SCR bucket.

```
policy VBR1
class class-default
  police rate <SCR> cps atm-mbs <MBS in cells> peak-rate <PCR> delay-tolerance <CDVT> us
    conform-action set-mpls-exp-imposition- transmit <EXP value>
    exceed-action drop
```

The same policy can be represented as percentage of the interface rate units, as in the following example:

```
policy VBR1
class class-default
  police rate <SCR in percent> percent atm-mbs <MBS in cells>
    peak-rate <PCR in percent> percent delay-tolerance <CDVT> us
    conform-action set-mpls-exp-imposition-transmit <EXP value>
    exceed-action drop
```

Variable Bit Rate—VBR.2 and VBR.3 Without Cell Tagging

VBR.2 and VBR.3 are real-time as well as non-real-time traffic and two rates are specified (PCR and SCR) to describe a VBR service category. All traffic exceeding the PCR is dropped. Please note that delay-tolerate (CDVT) needs to be specified for VBR conformance. Delay-tolerance is specified in microseconds. In addition, atm-mbs can also be specified which represents the burst that can be allowed on an SCR bucket.

The significant difference between the VBR.2/VBR.3 and VBR.1 is that the SCR bucket check is made only for CLP0 cells, that means CLP1 cells are not passed through the GCRA algorithm.

```
class atm_not_clp
  match not atm clp

policy child
  class atm_not_clp
    <any one form of the police below>
    police rate <SCR in cps> atm-mbs <MBS in cells>
      conform-action set-mpls-exp-imposition-transmit <EXP value>
      exceed-action drop
    police rate <SCR in percent> percent atm-mbs <MBS in cells> us
      conform-action set-mpls-exp-imposition-transmit
      exceed-action drop

policy VBR2
  class class-default
    <any one form of the police below>
    police rate <PCR in cps> delay-tolerance <cdvt in us>
```

```

        conform-action transmit
        exceed-action drop
    police rate <PCR in percent> percent delay-tolerance <cdvt in us> us
        conform-action transmit
        exceed-action drop
    service-policy child

```

Variable Bit Rate —VBR.3 with Cell Tagging

VBR.3 allows for tagging of the cells in case the SCR check failed.

```

class atm_not_clp
    match not atm clp

policy child
    class atm_not_clp
        <any one form of the police below>
        police rate <SCR in cps> atm-mbs <MBS in cells>
            conform-action set-mpls-exp-imposition-transmit <EXP value>
            exceed-action set-clp-transmit
            exceed-action set-mpls-exp-imposition-transmit <EXP value>
        police rate <SCR in percent> percent atm-mbs <MBS in cells> us
            conform-action set-mpls-exp-imposition-transmit
            exceed-action set-clp-transmit
            exceed-action set-mpls-exp-imposition-transmit <EXP value>
    policy VBR3
        class class-default
            <any one form of the police below>
            police rate <PCR in cps> delay-tolerance <cdvt in us>
                conform-action transmit
                exceed-action drop
            police rate <PCR in percent> percent delay-tolerance <cdvt in us> us
                conform-action transmit
                exceed-action drop
            service-policy child

```



Note

The `set-mpls-exp-imposition-transmit <EXP value>` can only be set in the parent policy. When you set the `set-mpls-exp-imposition-transmit <EXP value>` in the parent policy the child `conform-action set-mpls-exp-imposition-transmit <EXP value>` automatically takes the same `<EXP value>`. Only `conform-action transmit` is supported in the child policy. If `match not atm clp` is not configured, attempting to configure a policy will trigger an error.

Policing Configuration Excluding OAM Cells

```

class match-all atm_not_clp_not_oam
    match not atm clp
    match not atm oam

class match-all atm_not_oam
    match not atm oam

policy child
    class atm_not_clp_not_oam
        <any one form of the police below>
        police rate <SCR in cps> atm-mbs <MBS in cells>
            conform-action set-mpls-exp-imposition-transmit <EXP value>
            exceed-action set-clp-transmit
            exceed-action set-mpls-exp-imposition-transmit <EXP value>
        police rate <SCR in percent> percent atm-mbs <MBS in cells> us

```

```

conform-action set-mpls-exp-imposition-transmit
exceed-action set-clp-transmit
exceed-action set-mpls-exp-imposition-transmit <EXP value>

policy VBR3_non_OAM
  class atm_not_oam
    <any one form of the police below>
    police rate <PCR in cps> delay-tolerance <cdvt in us>
      conform-action transmit
      exceed-action drop
    police rate <PCR in percent> percent delay-tolerance <cdvt in us> us
      conform-action transmit
      exceed-action drop
  service-policy child

```

How to Configure ATMoMPLS Traffic Shaping

The following sections on ATMoMPLS traffic shaping relate only to Cisco 12000 ISE ATM (Engine 3 and Engine 5) line cards.

- [Configuring ATMoMPLS Per VC/VP Disposition Shaping, page 22](#)
- [Configuring ATMoMPLS Per-class Imposition Shaping, page 23](#)

The **match atm oam** and the **match atm clp** commands are now supported for ATM over MPLS. Matching on OAM cells and setting the MPLS EXP value is implemented on the imposition router.

For further information on *QoS: Match ATM OAM*

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s30/gsatmoam.htm>



Note

ATM over MPLS supports cell-packing with the criteria of OAM-based, CLP-based, or policer-result based packing. If the MQC policer configuration contains the **set-mpls-exp-imposition-transmit** policing action, then a policer-result based cell-packing is chosen. If the above configuration is present, the packing criteria is changed to CLP based packing. This will allow the MPLS packets with a specific EXP value and CLP to be packed into one packet. Please note that OAM cells will still be packed separately.

Table 5 lists the ATMoMPLS traffic shaping and WRED configuration commands supported in Cisco IOS Release 12.0(32)S.

Table 5 ATMoMPLS Set, Match, and WRED MQC Commands

| Supported Commands | Details |
|---------------------------|--|
| match all | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| match any | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| match atm-clp | Sets the ATM Cell Loss Priority bit to 1. |
| match atm oam-cell | Matching on OAM cells and setting EXP is implemented on the imposition router. |

Table 5 ATMoMPLS Set, Match, and WRED MQC Commands

| Supported Commands | Details |
|--|---|
| match mpls experimental <i>exp-value</i> | To configure a class map to use the specified value of the EXP field as a match criterion, use the match mpls experimental class-map configuration command. To remove the EXP field match criterion from a class map, use the no form of this command. |
| match qos-group <i>qos-group-value</i> | <p>The match qos-group command is used by the class map to identify a specific QoS group value marking on a packet. This command can also be used to convey the received Multiprotocol Label Switching (MPLS) experimental (EXP) field value to the output interface.</p> <p>The treatment of packets in a qos-group is defined through the configuration of QoS policies in policy-map class configuration mode. The <i>qos-group-value</i> is simply a group identifier, and does not indicate precedence or classification in itself.</p> <p>The <i>qos-group-value</i> is local to the router and is removed on egress from the router.</p> |
| set atm-clp | Setting the ATM cell loss priority bit (CLP-bit) is also supported as an exceed-action option. This command sets the CLP bit to one on all packets matching the specified class. This command can be used with the set mpls experimental imposition command in multiaction mode. |
| set discard-class | Use this command to specify the type of traffic to be dropped when there is congestion. There is no corresponding match action for discard-class for Cisco 12000 Series line cards. This command marks a packet on the Rx card so that WRED can be applied on the Tx card. |
| set mpls experimental imposition <i>exp-value</i> | Designates the value to which the MPLS bits are set if the packets match the specified policy map. |
| set qos-group <i>group-id</i> | The set qos-group command allows you to associate a group ID with a packet. The group ID can be used later to classify packets into QoS groups based as prefix, autonomous system, and community string. This action marks a packet on the Rx card so that Tx features such as policing and shaping can be applied to the matching packets on the Tx card. |
| bandwidth { <i>bw-value</i> [percent remaining] <i>percentage</i> > } } | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| priority | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |

Table 5 ATMoMPLS Set, Match, and WRED MQC Commands

| Supported Commands | Details |
|---|---|
| queue-limit <i>num-of-cells-or-pkts</i> | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| random-detect discard-class <i>value min-thr max-thr prob-den</i> | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |
| random-detect precedence <i>value min-thr max-thr prob-den</i> | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. Precedence=mpls-exp |
| shape { [max <i>buffer-limit</i>] [[peak average] <i>target-bit-rate</i>] } | Supported as per Cisco IOS Releases 12.0(27)S and 12.0(28)S. |

Configuring ATMoMPLS Per VC/VP Disposition Shaping

Per-VC shaping is implemented in the SAR and includes support for CBR, UBR and VBR shaping. The CLI for ATM shaping is not implemented for the Modular Quality of Service CLI (MQC) in Cisco IOS Release 12.0(32)S.

Constant Bit Rate Shaping—CBR

For Constant bit rate (CBR) shaping you must specify Conformance Definitions for PCR as shown in the following example:

```
interface atm 1/0
  pvc 100 12transport
    cbr <PCR 38 - 622000 kbps>
```

Variable Bit Rate Real Time Shaping—VBR-rt

For Variable Bit Rate Real Time (VBR-rt) shaping you must specify Conformance Definitions for PCR and SCR, as shown in the following example:

```
interface atm 1/0
  pvc 1/50
    vbr-rt <PCR 38 - 622000 kbps> <SCR 38 - PCR kbps>
```

Variable Bit Rate Non-Real Time Shaping—VBR-nrt

For Variable Bit Rate Non-Real Time (VBR-nrt) shaping you must specify Conformance Definitions for PCR and SCR, as shown in the following example:

```
interface atm 1/0
  pvc 1/50 12transport
    vbr-nrt <PCR 38 - 622000 kbps> <SCR>
```

Unspecified Bit Rate Shaping—UBR

For Unspecified Bit Rate Shaping (UBR) shaping you must specify Conformance Definitions for PCR, as shown in the following example:

```
interface atm 1/0
  pvc 1/50 12transport
    ubr <PCR 38 - 6220000 kbps>
```

For further information see, *QoS: ATM-CLP and Layer 2 CoS-Based WRED at the following URL:*
http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s28/12s_wred.htm

Configuring ATMoMPLS Per-class Imposition Shaping

Per-class imposition shaping is not supported for ATMoMPLS in Cisco IOS Release 12.0(32)S.

Configuration Examples for ATMoMPLS

Attaching Service Policy to Permanent Virtual Circuit: Example

```
interface ATM1/0.1 point-to-point
  pvc 1/101 l2transport
    xconnect 5.5.5.5 1145 encapsulation mpls
    service-policy input ingress_policy
```

Matching on ATM OAM Cells: Example

```
Class-map atm-oam
  match atm oam-cell

policy-map atm-oam
  class atm-oam
    set mpls experimental
```

Matching on ATM CLP: Example

```
Class-map atm-clp
  Match atm clp

Policy-map atsm-clp
  Class atm-clp
    Set mpls exp <EXP value>
```

How to Configure Traffic Policing and Shaping for EoMPLS

- [Configuring EoMPLS Policers, page 23](#)
- [Configuring EoMPLS Traffic Shaping, page 25](#)

Configuring EoMPLS Policers

- [EoMPLS Policer Restrictions, page 24](#)
- [Configuring the EoMPLS One-Rate Two-Color Policer, page 24](#)

- [Configuring the EoMPLS Two-Rate Three-Color Policer, page 24](#)

Table 6 EoMPLS Policer Commands for Cisco IOS Release 12.0(32)S

| Supported Policer Command, Option, or Action | Details |
|---|---|
| police cir <i>percentage</i> [<i>burst-in-ms</i>] [bc <i>conform-burst-in-msec</i> ms] [be <i>peak-burst-in-msec</i> ms] [pir <i>percentage</i> <i>percent</i>] | Configures traffic policing on the basis of the specified bandwidth percentage and optional burst sizes. Percentage-based policing and shaping is supported as in Cisco IOS Release 12.0(28)S. |
| police { cir <i>cir</i> } [bc <i>conform-burst</i>] { pir <i>pir</i> } [be <i>peak-burst</i>] [conform-action <i>action</i>] [exceed-action <i>action</i>]] | One-rate, Two-color traffic policer supported only on the Cisco 12000 Series 4-Port Gigabit Ethernet ISE line card, part number 4GE-SFP-LC. |
| police { cir <i>cir</i> } [bc <i>conform-burst</i>] { pir <i>pir</i> } [be <i>peak-burst</i>] [conform-action <i>action</i>] [exceed-action <i>action</i>] [violate-action <i>action</i>]]] | Two-rate, Three-color traffic policer supported on all Cisco 12000 Series Ethernet line cards. |
| set-mpls-exp-transmit <i>value</i> | This action is a conform-action and exceed-action option for the Two-rate Three-color policer. The set-mpls-exp-transmit option sets the Multiprotocol Label Switching (MPLS) experimental bits from 0 to 7 and sends the packet with the new MPLS experimental bit value setting. |
| violate-action drop | This violate-action option for the Two-rate Three-color policer causes the router to discard packets when the packet rate exceeds the peak information rate (PIR). |

EoMPLS Policer Restrictions

- The color-aware policer feature is supported for EoMPLS on Engine 3 and Engine 5 based line cards for Cisco 12000 starting in 32S.
- The one-rate two-color policer in color-blind mode is supported for EoMPLS on Engine 3 and Engine 5 based line cards for Cisco 12000.
- Two-rate three-color policer cannot be used in hierarchical policy which matches on VLAN IDs.

Configuring the EoMPLS One-Rate Two-Color Policer

In the following example, packets that exceed the policer criteria are dropped:

```
police cir 64000 bc 10000 be 20000 conform-action transmit exceed-action drop
```

Configuring the EoMPLS Two-Rate Three-Color Policer

Two-rate three-color policing can be configured for EoMPLS, Ethernet Local switching, VLANs, and Interworking in either the color-blind or the color-aware mode.

In the following example, traffic that exceeds the committed information rate (CIR), but is less than or equal to the peak information rate (PIR) is set with an experimental bit value of 5. Traffic that exceeds the PIR is dropped.

```
police cir 64000 bc 10000 pir 128000 be 20000 conform transmit exceed-action
set-experimental-transmit 5 violate-action drop
```

To make the policer color-aware .1p is used for color with the flexibility to use a single value of .1p COS or multiple values to represent the conform and exceed actions. For example:

```
class-map match-any green
  match cos 5

class-map match-any yellow
  match cos 4
  match cos 3

policy-map 2R3C_CA
  class class-default
    police cir 1600000 pir 3200000
    conform-color green exceed-color yellow
    conform-action set-mpls-exp-transmit 3
    exceed-action set-mpls-exp-transmit 4
    violate-action drop

interface Gi0/0.100
  service input 2R3C_policer_color_blind
```

Configuring EoMPLS Traffic Shaping

- [Configuring EoMPLS Per-VLAN Disposition Shaping, page 26](#)
- [Configuring EoMPLS Per-VLAN Imposition Shaping, page 27](#)
- [Configuring EoMPLS Per-Class Disposition Shaping, page 27](#)
- [Configuring EoMPLS Per-Class Imposition Shaping, page 28](#)

Table 7 lists the EoMPLS traffic shaping and WRED commands supported for EoMPLS in Cisco IOS Release 12.0(32)S.

Table 7 EoMPLS Match, Set and WRED Commands

| Supported Set Commands | Details |
|---|--|
| match any | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| match cos <i>cos-value</i> | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| match mpls experimental <i>value</i> | Matches the MPLS experimental (EXP) field. This command is not supported on the Cisco 12000. |
| match qos-group <i>group-id</i> | The match qos-group command is used by the class map to identify a specific QoS group value marking on a packet. This command can also be used to convey the received MPLS EXP field value to the output interface. |
| match vlan-group-id <i>vlan-id</i> | Matches the 802.1q VLAN ID. |

Table 7 EoMPLS Match, Set and WRED Commands

| Supported Set Commands | Details |
|---|---|
| set cos <i>cos-value</i> | Sets the 802.1p bits. The set cos command can be used only in service policies that are attached in the output direction of an interface. Packets entering an interface cannot be set with a Class of Service (CoS) value. |
| set discard-class discard <i>value</i> | Use this command to specify the type of traffic to be dropped when there is congestion. There is no corresponding match action for discard-class for Cisco 12000 Series line cards. This command marks a packet on the Rx card so that WRED can be applied on the TX card. |
| set mpls experimental imposition <i>exp-value</i> | Designates the value to which the MPLS bits are set if the packets match the specified policy map. |
| set qos-group <i>group-id</i> | The set qos-group command allows you to associate a group ID with a packet. The group ID can be used later to classify packets into QoS groups based as prefix, autonomous system, and community string. This action marks a packet on the Rx card so that Tx features such as policing and shaping can be applied to the matching packets on the Tx card. |
| bandwidth { <i>bw-value</i> [percent remaining] <i>percentage</i> > } | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| priority | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| queue-limit <i>num-of-cells-or-pkts</i> | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| random-detect discard-class <i>value min-thr max-thr prob-den</i> | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |
| random-detect precedence <i>value min-thr max-thr prob-den</i> | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. Precedence=mpls experimental |
| shape { [max <i>buffer-limit</i>] [peak average] <i>target-bit-rate</i> } | Supported as per Cisco IOS Releases 12.0(26)S, 12.0(27)S and 12.0(28)S. |

Configuring EoMPLS Per-VLAN Disposition Shaping

Per-VLAN egress traffic shaping at disposition is supported as shown in the following hierarchical service policy:

```

policy-map parent
  class-map class-default
  shape average 128000000
  service-policy child

```

```

policy-map child
  class match_qos3
    set cos 3
    shape average 16000000
    bandwidth percent 5
  class match_qos12
    set cos 1
    shape average 6400000
    random-detect discard-class-based
    random-detect discard-class 1 500 packets 1000 packets
    random-detect discard-class 2 1000 packets 2000 packets
    bandwidth percent 10
  class class-default
    set cos 4
    shape average 2560000
    queue-limit 100 packets
    bandwidth percent 1

interface GigabitEthernet6/1
  no ip address
  no ip directed-broadcast
  no negotiation auto
  no cdp enable

interface GigabitEthernet6/1.1
  encapsulation dot1Q 601
  no ip directed-broadcast
  no cdp enable
  xconnect 8.8.8.8 601 encapsulation mpls
  service-policy input set_exp2
  service-policy output match_qos_discard_cos_parent

```

Configuring EoMPLS Per-VLAN Imposition Shaping

Per-VLAN input traffic shaping on imposition for EoMPLS sub-interfaces can only match on CoS (802.1p bits) or class-default, as shown in the following configuration:

```

class-map match_cos1
  match cos 1

policy-map input_shaping_policy
  class match_cos1
    shape average 128000000

interface GigabitEthernet6/1.1
  encapsulation dot1Q 601
  no ip directed-broadcast
  no cdp enable
  xconnect 8.8.8.8 601 encapsulation mpls
  service-policy input input_shaping_policy

```

Configuring EoMPLS Per-Class Disposition Shaping

For EoMPLS per-class disposition traffic shaping, match on the MPLS experimental value on the ingress disposition card, then set the **qos-group** and the **discard-class** (if necessary).

On the egress port on the disposition router, match and shape on the class represented by the qos-group. WRED can be applied on discard-class values.

The following procedure demonstrates the steps recommended to configure EoMPLS per-class disposition shaping:

Step 1 Define the classes for matching the MPLS experimental values.

```
class-map match-any exp1
  match mpls exp 1

class-map match-any exp2
  match mpls exp 2
```

Step 2 Define the ingress policy to be applied to the RX interface.

```
policy-map ingress-policy
  class exp1
    set qos-group 1
    set discard-class 1
  class exp2
    set qos-group 2
    set discard-class 2
```

Step 3 Define the classes for matching on qos-group on egress.

```
class-map match-all qos1
  match qos-group 1
class-map match-all qos2
  match qos-group 2
```

Step 4 Define the egress policy to be applied to TX interface.

```
policy-map egress-policy
  class qos1
    bandwidth percent 10
    shape average 64000000
    random-detect discard-class-based
    random-detect discard-class 1 1000 2000
    random-detect discard-class 2 2000 3000
```

Configuring EoMPLS Per-Class Imposition Shaping

On the imposition side, it is possible to use a policy to match on p-bits and set the experimental bits accordingly. In Release 12.0(25)S, on the disposition side, the MPLS experimental bit is copied to p-bits by default. Since Cisco IOS Release 12.0(30)S, you can map any MPLS experimental bit to any p-bit value in the egress side of the disposition router. To do this, an input policy on the Rx disposition card should be created to carry EXP values into the **qos-group** values. On the Tx disposition card, an output policy should be created to perform a mapping between **qos-group** and p-bit values as shown in the following example:

Input Policy

```
policy-map set_qos_discard
  class match_exp1
    set qos-group 1
    set discard-class 1
  class match_exp2
    set qos-group 2
    set discard-class 2
  class match_exp3
    set qos-group 3
    set discard-class 3
```

Output Policy

```
policy-map set_cos
```

```
class match_qos1
  set cos 1
class match_qos2
  set cos 2
class match_qos3
  set cos 3
```

Configuration Examples for Ethernet over MPLS

The following sample configurations are listed in this section:

- [Attaching Service Policy to the Main Interface \(Port Mode\): Example, page 29](#)
- [Attaching Service Policy to Subinterface \(VLAN\): Example, page 29](#)
- [EoMPLS Customer-facing Interface Configuration: Example, page 29](#)

Attaching Service Policy to the Main Interface (Port Mode): Example

```
int Gigaethernet4/0
  xconnect 5.5.5.5 1045 encapsulation mpls
  service-policy input ingress_policy
```

Attaching Service Policy to Subinterface (VLAN): Example

```
int Gigaethernet4/0.1
  encapsulation dot1Q 200
  xconnect 5.5.5.5 1045 encapsulation mpls
  service-policy input ingress_policy
```

EoMPLS Customer-facing Interface Configuration: Example

```
int Gi0/0
  service input match-vlan123
int Gi0/0.100
  service input 2R3C_policer_color_blind
  service output match_qos_discard_cos_parent
int Gi0/0.101
  service input map_cos_to_exp
  service output match_qos_discard_cos_parent
int Gi0/0.102
  service input shape_16mbps
  service output match_qos_discard_cos_parent
```

Additional Configuration Examples for Any Transport over MPLS (AToM): Layer 2 QoS (Quality of Service)

Attaching Service Policy to Main Interface (PPP or HDLCoMPLS): Example

```
interface POS4/0
  xconnect 5.5.5.5 1045 encapsulation mpls
  service-policy input ingress_policy
```

Example Policy Templates

```
policy-map 2R3C_policer_color_blind
  class class-default
    police cir ... pir ...

policy-map 2R3C_policer_color_aware
  class class-default
    police cir ... pir ...
    conform-color match-not-frde exceed-color match-frde

policy-map 1R2C_policer
  class class-default
    police cir ...

policy-map set_exp_from_frde
  class match-fr-de
    set mpls exp imp 3
  class class-default
    set mpls exp imp 2

policy-map match-qos-discard
  class match_qos3
    bandwidth percent 5
    shape average 160000000
  class match_qos12
    shape average 64000000
    random-detect discard-class-based
    random-detect discard-class 1 500 packets 1000 packets
    random-detect discard-class 2 1000 packets 2000 packets
    bandwidth percent 10
  class class-default
    shape average 64000000
    queue-limit 1000 packets
    bandwidth percent 1

policy-map shape_16mbps
  class class-default
    shape average 16000000

policy-map match_qos_discard_cos_parent
  class class-default
    shape average 128000000
    service-policy match_qos_discard_cos

policy-map match_qos_discard_cos
  class match_qos3
    set cos 3
```

```

        shape average 16000000
        bandwidth percent 5
    class match_qos12
        set cos 1
        shape average 64000000
        random-detect discard-class-based
        random-detect discard-class 1 500 packets 1000 packets
        random-detect discard-class 2 1000 packets 2000 packets
        bandwidth percent 10
    class class-default
        set cos 4
        shape average 2560000
        queue-limit 100 packets
        bandwidth percent 1

policy-map map_cos_to_exp
    class match_cos1
        set mpls experimental 1
    class match_cos2
        set mpls experimental 2
    class match_cos3
        set mpls experimental 1

policy-map match-vlan123
    class match-vlan-1
        service-policy 2R3C_policer_color_blind
    class match-vlan-2
        service-policy map_cos_to_exp
    class match-vlan-3
        service-policy shape_16mbps

```

Additional References

The following sections provide references related to Any Transport over MPLS (AToM): Layer 2 QoS (Quality of Service):

Related Documents

| Related Topic | Document Title |
|---|---|
| For further information on configuring QoS policing and traffic shaping | <i>Cisco IOS Quality of Service Solutions Configuration Guide, Release 12.3</i> http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123cgr/qos_vcg.htm |
| Color Aware Policing | <i>QoS: Color-Aware Policer</i> http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s26/12s_cap.htm |
| Support for all Modular QoS CLI features in Cisco IOS Release 12.0(27)S | <i>New Features in Release 12.0(27)S</i> http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s27/index.htm |

Additional References

| Related Topic | Document Title |
|---|---|
| Support for all Modular QoS CLI features in Cisco IOS Release 12.0(28)S | <i>New Features in Release 12.0(28)S</i> http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s28/index.htm |
| Layer 2 Transport Configuration over MPLS | <i>Any Transport over MPLS</i> http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s28/fsatom28.htm#wp1046865 |

Standards

| Standards | Title |
|---|--|
| draft-martini-l2circuit-trans-mpls-08.txt | <i>Transport of Layer 2 Frames Over MPLS</i> |
| draft-martini-l2circuit-encap-mpls-04.txt | <i>Encapsulation Methods for Transport of Layer 2 Frames over MPLS</i> |

MIBs

| MIBs | MIBs Link |
|--|---|
| <p>ATM AAL5 over MPLS and ATM Cell Relay over MPLS:</p> <ul style="list-style-type: none"> MPLS LDP MIB (MPLS-LDP-MIB.my) ATM MIB (ATM-MIB.my) CISCO AAL5 MIB (CISCO-AAL5-MIB.my) Cisco Enterprise ATM Extension MIB (CISCO-ATM-EXT-MIB.my) Supplemental ATM Management Objects (CISCO-IETF-ATM2-PVCTRAP-MIB.my) Interfaces MIB (IF-MIB.my) <p>Ethernet over MPLS</p> <ul style="list-style-type: none"> CISCO-ETHERLIKE-CAPABILITIES.my Ethernet MIB (ETHERLIKE-MIB.my) Interfaces MIB (IF-MIB.my) MPLS LDP MIB (MPLS-LDP-MIB.my) <p>Frame Relay over MPLS</p> <ul style="list-style-type: none"> Cisco Frame Relay MIB (CISCO-FRAME-RELAY-MIB.my) Interfaces MIB (IF-MIB.my) MPLS LDP MIB (MPLS-LDP-MIB.my) <p>HDLC and PPP over MPLS</p> <ul style="list-style-type: none"> MPLS LDP MIB (MPLS-LDP-MIB.my) Interface MIB (IF-MIB.my) | <p>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</p> <p>http://www.cisco.com/go/mibs</p> |

RFCs

| RFCs | Title |
|----------|---|
| RFC-2697 | <i>A Single-Rate Three-Color Marker</i> |
| RFC-2698 | <i>A Two-Rate Three-Color Marker</i> |
| RFC 3032 | <i>MPLS Label Stack Encoding</i> |
| RFC 3036 | <i>LDP Specification</i> |

Technical Assistance

| Description | Link |
|--|---|
| Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content. | http://www.cisco.com/public/support/tac/home.shtml |

Command Reference

There are no new Cisco IOS commands introduced with this feature.

CCSP, CCVP, the Cisco Square Bridge logo, Follow Me Browsing, and StackWise are trademarks of Cisco Systems, Inc.; Changing the Way We Work, Live, Play, and Learn, and iQuick Study are service marks of Cisco Systems, Inc.; and Access Registrar, Aironet, ASIST, BPX, Catalyst, CCDA, CCDP, CCIE, CCIP, CCNA, CCNP, Cisco, the Cisco Certified Internetwork Expert logo, Cisco IOS, Cisco Press, Cisco Systems, Cisco Systems Capital, the Cisco Systems logo, Cisco Unity, Empowering the Internet Generation, Enterprise/Solver, EtherChannel, EtherFast, EtherSwitch, Fast Step, FormShare, GigaDrive, GigaStack, HomeLink, Internet Quotient, IOS, IP/TV, iQ Expertise, the iQ logo, iQ Net Readiness Scorecard, LightStream, Linksys, MeetingPlace, MGX, the Networkers logo, Networking Academy, Network Registrar, *Packet*, PIX, Post-Routing, Pre-Routing, ProConnect, RateMUX, ScriptShare, SlideCast, SMARTnet, StrataView Plus, TeleRouter, The Fastest Way to Increase Your Internet Quotient, and TransPath are registered trademarks of Cisco Systems, Inc. and/or its affiliates in the United States and certain other countries.

All other trademarks mentioned in this document or Website are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (0502R)

Copyright © 2006 Cisco Systems, Inc. All rights reserved.