MPLS Class of Service

Feature Overview

The Class of Service (CoS) feature for Multiprotocol Label Switching (MPLS) enables network administrators to provide differentiated types of service across an MPLS network. Differentiated service satisfies a range of requirements by supplying for each packet transmitted the particular kind of service specified for that packet by its CoS. Service can be specified in different ways, for example, using the IP precedence bit settings in IP packets.

In supplying differentiated service, MPLS CoS offers packet classification, congestion avoidance, and congestion management. Table 1 lists these functions and their descriptions.

Table 1 CoS Services and Features

Service	CoS Function	Description
Packet classification	Committed access rate (CAR). Packets are classified at the edge of the network before labels are assigned.	CAR uses the type of service (TOS) bits in the IP header to classify packets according to input and output transmission rates. CAR is often configured on interfaces at the edge of a network in order to control traffic into or out of the network. You can use CAR classification commands to classify or reclassify a packet.
Congestion avoidance	Weighted random early detection (WRED). Packet classes are differentiated based on drop probability.	WRED monitors network traffic, trying to anticipate and prevent congestion at common network and internetwork bottlenecks. WRED can selectively discard lower priority traffic when an interface begins to get congested. It can also provide differentiated performance characteristics for different classes of service.
Congestion management	Weighted fair queueing (WFQ). Packet classes are differentiated based on bandwidth and bounded delay.	WFQ is an automated scheduling system that provides fair bandwidth allocation to all network traffic. WFQ uses weights (priorities) to determine how much bandwidth each class of traffic is allocated.

For more information on configuration of the CoS functions (CAR, WRED, and WFQ), see the Cisco IOS *Quality of Service Solutions Configuration Guide*.

For complete command syntax information for CAR, WRED, and WFQ, see the Cisco IOS *Quality of Service Solutions Command Reference.*

MPLS CoS lets you duplicate Cisco IOS IP CoS (Layer 3) features as closely as possible in MPLS devices, including label edge routers (LERs), label switch routers (LSRs), and asynchronous transfer mode LSRs (ATM LSRs). MPLS CoS functions map nearly one-for-one to IP CoS functions on all interface types.

Tag Switching/MPLS Terminology

The following table lists the old Tag Switching terms and the new MPLS terms found in this document.

Old Designation	New Designation
Tag Switching	MPLS, Multiprotocol Label Switching
Tag (short for Tag Switching)	MPLS
Tag (item or packet)	Label
TDP (Tag Distribution Protocol)	LDP (Label Distribution Protocol) **Note** Cisco TDP and LDP (MPLS Label Distribution Protocol)) are nearly identical in function, but use incompatible message formats and some different procedures. Cisco will be changing from TDP to a fully compliant LDP.
Tag Switched	Label Switched
TFIB (Tag Forwarding Information Base)	LFIB (Label Forwarding Information Base)
TSR (Tag Switching Router)	LSR (Label Switching Router)
TSC (Tag Switch Controller)	LSC (Label Switch Controller)
ATM-TSR	ATM-LSR (ATM Label Switch Router, for example, BPX 8650.)
TVC (Tag VC, Tag Virtual Circuit)	LVC (Label VC, Label Virtual Circuit)
TSP (Tag Switch Protocol)	LSP (Label Switch Protocol)
XTagATM (extended Tag ATM port)	XmplsATM (extended mpls ATM port)

MPLS CoS

Several different methods exist for supporting CoS across an MPLS backbone, the choice depending on whether the core has label switch routers (LSRs) or ATM LSRs. In each case, however, the CoS building blocks are the same: CAR, WRED, and WFQ.

Three configurations are described below:

- LSRs used at the core of the network backbone
- ATM LSRs used at the core of the network backbone
- ATM switches without the MPLS feature enabled

LSRs

LSRs at the core of the MPLS backbone are usually either Cisco 7200 and Cisco 7500 series routers running MPLS software. Packets are processed as follows:

1 IP packets enter into the edge of the MPLS network.

2. The edge LSRs invoke CAR to classify the IP packets and possibly set IP precedence. Alternatively, IP packets can be received with their IP precedence already set.
3. For each packet, the router performs a lookup on the IP address to determine the next-hop LSR.
4. The appropriate label is placed on the packet with the IP precedence bits copied into every label entry in the MPLS header.
5. The labeled packet is then forwarded to the appropriate output interface for processing.
6. The packets are differentiated by class. This is done according to drop probability (WRED) or according to bandwidth and delay (WFQ). In either case, LSRs enforce the defined differentiation by continuing to employ WRED or WFQ on each hop.

ATM LSRs

ATM LSRs at the core implement the multiple label virtual circuit model (LVC). In the multiple LVC model, one label is assigned for each service class for each destination. The operation of the edge LSR is the same as that described previously for the LSR case, except that the output is an ATM interface. WRED is used to define service classes and determine discard policy during congestion.

In the multiple LVC model, however, class-based WFQ is used to define the amount of bandwidth available to each service class. Packets are scheduled by class during congestion. The ATM LSRs participate in the differentiation of classes with WFQ and intelligently drop packets when congestion occurs. The mechanism for this discard activity is weighted early packet discard (WEPD).

ATM Switches

When the core network uses ATM switches and the edge of the network uses MPLS-enabled edge LSRs, the edge LSRs are interconnected through a mesh of ATM Forum PVCs (CBR, VBR, or UBR) over the ATM core switches. The edge LSRs invoke WFQ on a per-VC basis to provide differentiation based on the delay of each MPLS CoS multiplexed onto the ATM Forum PVC. Optionally, WRED can also be used on a per-VC basis to manage drop priority between classes when congestion occurs on the edge LSR.

Table 2 lists the MPLS CoS features supported on packet interfaces in this release.

Table 2 MPLS CoS Features Supported on Packet Interfaces

	Cisco 7500 Series	Cisco 7200 Series	Cisco 4x00 Series	Cisco 36x0 Series	Cisco 2600 Series
MPLS CoS Packet Feature					
Per-interface WRED	X	X	X	X	Untested
Per-interface, per-flow WFQ	X	X	X	X	Untested
Per-interface, per-class WFQ	X	X	X	X	Untested

Table 3 lists the MPLS CoS features supported on ATM interfaces in this release.

Table 3 MPLS CoS Features Supported on ATM Interfaces

	Cisco 7500 Series	Cisco 7200 Series	Cisco 4x00 Series	Cisco 36x0 Series	Cisco 2600 Series
MPLS CoS ATM Forum PVCs Feature					
Per-VC WRED	X[1]	X[1]	N/A	N/A	N/A
Per-VC WRED and per VC, per-class WFQ	N/A	X[1]	N/A	N/A	N/A
MPLS CoS Multi-VC or LBR Feature					
Per-interface WRED	X[2]	X[2]	N/A	N/A	N/A
Per-interface, per-class WFQ	X[2]	X[2]	N/A	N/A	N/A

1 This feature is only available on the ATM Deluxe (PA-A3).
2 This feature is only available on the ATM Lite (PA-A1).

Table 4 lists the MPLS CoS features supported on ATM switches.

Table 4 MPLS CoS Features Supported on ATM Switches and Interfaces

	BPX 8650 Series	MGX 8800 Series	LightStream 1010 ATM Switch[1]	Catalyst 8540 MSR[1]
MPLS CoS ATM Forum PVCs	X	X	X	X
MPLS CoS Multi-VC or LBR—per-class WFQ	X	N/A	N/A	N/A

1 This can be used for the core only.

Benefits

MPLS CoS provides the same benefits as IP CoS when implemented on a backbone built purely of routers. The following benefits are realized when implementing IP CoS on a backbone of ATM switches using MPLS:

Efficient resource allocation—WFQ is used to allocate bandwidth on a per-class and per-link basis. Classes of traffic are guaranteed a percentage of link bandwidth, thereby maximizing the transport of paid traffic.

No connections to configure—Implementing IP CoS with MPLS requires no configuration of end-to-end VCs for each class of service. This advantage is especially beneficial when integrating MPLS CoS support in conjunction with an MPLS VPN service. Traditional methods of configuring IP CoS with ATM would require configuring and provisioning a separate end-to-end VC for each class of service for each VPN.

Flexibility without added overhead—MPLS CoS promotes the efficient use of bandwidth, because unused bandwidth allocated to a class is available to all other classes if needed. Furthermore, MPLS CoS requires no call setup procedure, because reachability and resource allocation are established before the initiation of service.

Related Features and Technologies

You can use MPLS CoS with:

- The MPLS Virtual Private Networks (VPNs) feature
- Any MPLS network

Related Documents

- *MPLS Virtual Private Networks Feature Guide*

Supported Platforms

The following is a list of router platforms supported at the provider core.

- Cisco 8800 series (MGX) (ATM Forum PVCs and multi VC or LBR - per class WFQ)
- Cisco BPX 8650 IP+ATM switch (ATM Forum PVCs only)
- Cisco 7500 series (ATM Forum PVCs and multi VC or LBR - per class WFQ)
- Cisco 7200 series (ATM Forum PVCs multi VC or LBR - per class WFQ)

The following is a list of router platforms supported at the provider edge.

- Cisco 7500 series routers (Edge LSR or LSR)
- Cisco 7200 series routers (Edge LSR or LSR)
- Cisco 45x0 series routers (POS interfaces only—Edge LSR or LSR)
- Cisco 36x0 series routers (POS interfaces only—Edge LSR or LSR)

Supported Standards, MIBs and RFCs

MIBs

- CISCO-WRED-MIB
- CISCO-CAR-MIB
- CISCO-WRED-MIB

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB website on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

No new or modified RFCs are supported by this feature.

Standards

No new or modified standards are supported by this feature.

Prerequisites

To use the MPLS CoS feature, your network must be running the following Cisco IOS features:

- CEF switching in every MPLS-enabled router
- MPLS
- ATM functionality (If you are using packet interfaces only, you do not need ATM functionality)

Configuration Tasks

Perform the tasks in the following sections to configure the MPLS CoS feature.

- Configuring PVC Mode in a Non-MPLS-Enabled Core
- Configuring Multi-VC Mode in a MPLS-Enabled Core
- Configuring Multi-VCs Using the Cos-Map Function
- Configuring DWFQ and Changing Queue Weights on an Outgoing Interface
- Verifying CoS Operation

Configuring PVC Mode in a Non-MPLS-Enabled Core

To configure a PVC in a non-MPLS-enabled core, use the following commands in the order specified in configuration mode:

Step	Command	Purpose
1	`Router(config)# interface type number point-to-point`	Configures a point-to-point ATM subinterface.
2	`Router(config-subif)# ip unnumbered Loopback0`	Assigns IP address to the subinterface.
3	`Router(config-subif)# pvc 4/40`	Creates a PVC on the subinterface.
4	`Router(config-if-atm-vc)# random-detect attach groupname`	Activates (D)WRED on the interface.
5	`Router(config-if-atm-vc)# encapsulation aal5snap`	Sets encapsulation type for the PVC.
6	`Router(config-subif)# exit`	Exits from PVC mode and enters subinterface mode.
7	`Router(config-subif)# tag-switching ip`	Enables MPLS IP on the point-to-point interface.

Configuring Multi-VC Mode in a MPLS-Enabled Core

To configure multi-VC mode in an MPLS-enabled core, use the following commands in the order specified in configuration mode:

Note The default for the multi-VC mode creates four VCs for each MPLS destination.

Step	Command	Purpose
1	`Router(config)# interface type number tag-switching`	Configures an ATM MPLS subinterface.
2	`Router(config-subif)# ip unnumbered Loopback0`	Assigns IP address to the subinterface.
3	`Router(config-subif)# tag-switching atm multi-vc`	Enables ATM multi-VC mode on the subinterface.
4	`Router(config-subif)# tag-switching ip`	Enables MPLS on the ATM subinterface.

Configuring Multi-VCs Using the Cos-Map Function

If you do not choose to use the default for configuring label VCs, you can configure fewer label VCs by using the CoS map function. To use the CoS map function, perform the following steps:

Step	Command	Purpose
1	`Router(config)# tag-switching cos-map cos-map number`	Creates a CoS map.
2	`Router(config-tag-cos-map)# class 1 premium`	Enters the cos-map submode and maps premium and standard classes to label VCs. This CoS map assigns class 1 traffic to share the same label VC as class 2 traffic. The numbers you assign to the CoS map range from 0 to 3. The defaults are: • class 0 is available • class 1 is standard • class 2 is premium • class 3 is control
3	`Router(config-tag-cos-map)# exit`	Exits the MPLS CoS map submode.
4	`Router(config)# access-list access-list-number permit destination`	Creates an access list. The access list acts on traffic going to the specified destination address.
5	`Router(config)# tag-switching prefix-map prefix-map access-list access-list cos-map cos-map`	Configures the router to use a specified CoS map when a MPLS destination prefix matches the specified access list.

Configuring DWFQ and Changing Queue Weights on an Outgoing Interface

To configure distributed fair queueing and change queue weights on an interface, use the following commands in interface configuration mode after specifying the interface:

Step	Command	Purpose
1	`Router(config)# interface type number`	Specifies the interface type and number.
2	`Router(config-if)# fair-queue tos`	Configures an interface to use fair queueing
3	`Router(config)# fair-queue tos class weight`	Changes the class weight on the specified interface.

Verifying CoS Operation

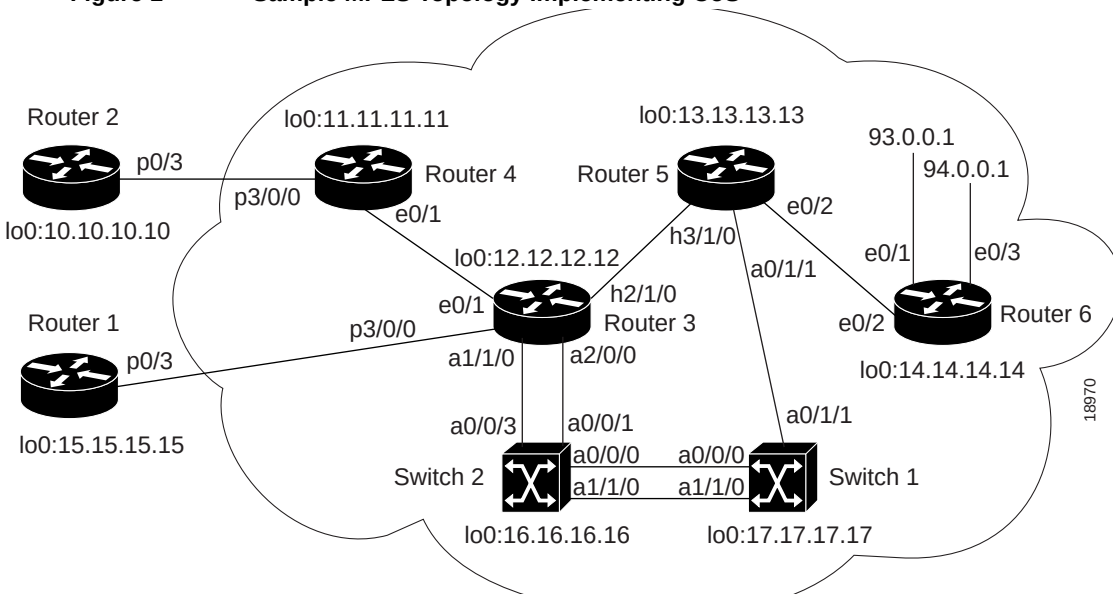
To verify the operation of MPLS CoS, perform the following steps:

Step	Command	Purpose
1	`Router# show tag-switching interfaces interfaces`	Displays detailed information about tag switching interfaces.
2	`Router# show tag-switching cos-map`	Displays the CoS map used to assign VCs.
3	`Router# show tag-switching prefix-map`	Displays the prefix map used to assign a CoS map to network prefixes.

Configuration Examples

Figure 1 illustrates a sample MPLS topology that implements the MPLS CoS feature. The following sections contain the configuration commands entered on Routers1 to 6 and on Switches 1 and 2 included in this figure.

Figure 1 Sample MPLS Topology Implementing CoS



Configuring Cisco Express Forwarding (CEF)

These configuration commands enable Cisco express forwarding (CEF). CEF switching is a prerequisite for the MPLS feature and must be running on all routers in the network.

```
ip cef distributed
tag-switching ip
!
```

Running IP on Router 2

The following commands enable IP routing on Router 2. All routers must have IP enabled.

Note Router 2 is not part of the MPLS network.

```
!
ip routing
!
hostname R2
!
interface Loopback0
 ip address 10.10.10.10 255.255.255.255
!
```

```
interface POS0/3
 ip unnumbered Loopback0
 crc 16
 clock source internal
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 100
!
```

Running IP on Router 1

The following commands enable IP routing on Router 1.

Note Router 1 is not part of the MPLS network.

```
ip routing
!
hostname R1
!
interface Loopback0
 ip address 15.15.15.15 255.255.255.255
!
interface POS0/3
 ip unnumbered Loopback0
 crc 16
 clock source internal
!
router ospf 100
 network 15.0.0.0 0.255.255.255 area 100
```

Running MPLS on Router 4

Router 4 is a label edge router. CEF and the MPLS feature must be enabled on this router. Committed Access Rate (CAR) is also configured on Router 4 on interface POS3/0/0 (see the section on Configuring CAR).

```
!
hostname R4
!
ip routing
tag-switching ip
tag-switching advertise-tags
!
ip cef distributed
!
interface Loopback0
 ip address 11.11.11.11 255.255.255.255
!
interface Ethernet0/1
 ip address 90.0.0.1 255.0.0.0
 tag-switching ip
!
```

Configuring CAR

Lines 3 and 4 contain the CAR rate policies. It sets the committed information rate (CIR) at 155,000,000 bits and the normal burst/maximum burst size at 200,000/800,000 bytes. The conform action (action to take on packets) sets the IP precedence and transmits the packets that conform to the rate limit. The exceed action sets the IP precedence and transmits the packets when the packets exceed the rate limit.

```
!
interface POS3/0/0
 ip unnumbered Loopback0
 rate-limit input 155000000 2000000 8000000 conform-action set-prec-transmit 5
 exceed-action set-prec-transmit 1
 ip route-cache distributed
!
router ospf 100
 network 11.0.0.0 0.255.255.255 area 100
 network 90.0.0.0 0.255.255.255 area 100
```

Running MPLS on Router 3

Router 3 is running MPLS. CEF and the MPLS feature must be enabled on this router. Router 3 contains interfaces that are configured for WRED, multi-VC, per VC WRED, WFQ, and CAR. The following sections contain these sample configurations.

```
!
hostname R3
!
ip cef distributed
!
interface Loopback0
 ip address 12.12.12.12 255.255.255.255
!
interface Ethernet0/1
 ip address 90.0.0.2 255.0.0.0
 tag-switching ip
```

Configuring Point-to-Point WRED

The following commands configure WRED on an ATM interface. In this example, the commands refer to a PA-A1 (ATM Lite).

```
!
interface ATM1/1/0
 ip route-cache distributed
 atm clock INTERNAL
 random-detect
!
```

Configuring an Interface for Multi-VC Mode

The following commands configure interface ATM1/1/0 for multi-VC mode. In this example, the commands refer to a PA-A1 (ATM Lite).

```
!
interface ATM1/1/0.1 tag-switching
 ip unnumbered Loopback0
 tag-switching atm multi-vc
 tag-switching ip
!
```

Configuring Per VC WRED

The following commands configure per VC WRED on a PA-A3 (ATM Deluxe) only.

Note The PA-A1 (ATM Lite) does not support the per-VC WRED drop mechanism.

```
!interface ATM2/0/0
 no ip address
 ip route-cache distributed

interface ATM2/0/0.1 point-to-point
 ip unnumbered Loopback0
 no ip directed-broadcast
 pvc 10/100
  random-detect
  encapsulation aal5snap
  exit
 !
 tag-switching ip
```

Configuring WRED and WFQ

Lines 5 and 6 contain the commands for configuring WRED and WFQ on interface Hssi2/1/0.

```
!
interface Hssi2/1/0
 ip address 91.0.0.1 255.0.0.0
 ip route-cache distributed
 tag-switching ip
 random-detect
 fair queue tos
hssi internal-clock
!
```

Configuring CAR

Lines 3 and 4 contain the CAR rate policies. It sets the committed information rate (CIR) at 155,000,000 bits and the normal burst/maximum burst size at 200,000/800,000 bytes. The conform action (action to take on packets) sets the IP precedence and transmits the packets that conform to the rate limit. The exceed action sets the IP precedence and transmits the packets when the packets exceed the rate limit.

```
!
interface POS3/0/0
 ip unnumbered Loopback0
 rate-limit input 155000000 2000000 8000000 conform-action set-prec-transmit 2
 exceed-action set-prec-transmit 2
 ip route-cache distributed
!
router ospf 100
 network 12.0.0.0 0.255.255.255 area 100
 network 90.0.0.0 0.255.255.255 area 100
 network 91.0.0.0 0.255.255.255 area 100
!
ip route 93.0.0.0 255.0.0.0 Hssi2/1/0 91.0.0.2
!
```

Running MPLS on Router 5

Router 5 is running the MPLS feature. CEF and the MPLS feature must be enabled on this router. Router 5 has also been configured to create an ATM subinterface in Multi-VC mode and to create a PVC on a Point-to-Point subinterface. The sections that follow contain these sample configurations.

```
!
hostname R5
!
ip cef distributed
!
interface Loopback0
 ip address 13.13.13.13 255.255.255.255
!
 interface Ethernet0/2
 ip address 92.0.0.1 255.0.0.0
 tag-switching ip
```

Configuring an ATM Interface

The following commands create an ATM interface.

```
!
interface ATM1/0/0
 no ip address
 ip route-cache distributed
 atm clock INTERNAL
!
```

Configuring an ATM MPLS Subinterface in Multi-VC Mode

The following commands create an MPLS subinterface in multi-VC mode.

```
!
interface ATM1/0/0.1 tag-switching
 ip unnumbered Loopback0
 tag-switching atm multi-vc
 tag-switching ip
!
```

Configuring a PVC on Point-to-Point Subinterface

The following commands create a PVC on a point-to-point subinterface (interface ATM1/0/0.2).

```
!
interface ATM1/0/0.2 point-to-point
 ip unnumbered Loopback0
 pvc 10/100
  random-detect
  encapsulation aal5snap
  exit
 !
 tag-switching ip
!
interface Hssi3/0
 ip address 91.0.0.2 255.0.0.0
 tag-switching ip
 hssi internal-clock
!
router ospf 100
 network 13.0.0.0 0.255.255.255 area 100
 network 91.0.0.0 0.255.255.255 area 100
 network 92.0.0.0 0.255.255.255 area 100
!
```

Running MPLS on Router 6

Router 6 is running the MPLS feature. CEF and the MPLS feature must be enabled on this router.

```
!
hostname R6
!
ip cef distributed
!
interface Loopback0
 ip address 14.14.14.14 255.255.255.255
!
interface Ethernet0/1
 ip address 93.0.0.1 255.0.0.0
 tag-switching ip
!
interface Ethernet0/2
 ip address 92.0.0.2 255.0.0.0
 tag-switching ip
!
interface Ethernet0/3
 ip address 94.0.0.1 255.0.0.0
 tag-switching ip
!
router ospf 100
 network 14.0.0.0 0.255.255.255 area 100
 network 92.0.0.0 0.255.255.255 area 100
 network 93.0.0.0 0.255.255.255 area 100
 network 94.0.0.0 0.255.255.255 area 100
!
```

Configuring ATM Switch 2

Switch 2 is configured for MPLS and creates an ATM Forum PVC.

```
!
hostname S2
!
interface Loopback0
 ip address 16.16.16.16 255.255.255.255
!
interface ATM0/0/0
 ip unnumbered Loopback0
 tag-switching ip
!
interface ATM0/0/1
 ip unnumbered Loopback0
 tag-switching ip
 atm pvc 10 100 interface ATM0/0/0 10 100

interface ATM0/0/2
 no ip address
 no ip directed-broadcast
!
interface ATM0/0/3
 ip unnumbered Loopback0
 tag-switching ip
!
interface ATM1/1/0
 ip unnumbered Loopback0
 tag-switching ip
!
router ospf 100
 network 16.0.0.0 0.255.255.255 area 100
!
```

Configuring ATM Switch 1

Switch 1 is configured to create an ATM Forum PVC.

```
!
hostname S1
!
interface Loopback0
 ip address 17.17.17.17 255.255.255.255
!
interface ATM0/0/0
 ip unnumbered Loopback0
 tag-switching ip
!
```

Configuring Label VCs and an ATM Forum PVC

Line 3 contains the configuration command for an ATM Forum PVC.

```
!
interface ATM0/1/1
 ip unnumbered Loopback0
 atm pvc 10 100  interface  ATM0/0/0 10 100
 tag-switching ip
!
interface ATM1/1/0
 ip unnumbered Loopback0
 tag-switching ip
!
router ospf 100
 network 17.0.0.0 0.255.255.255 area 100
!
```

Command Reference

This section documents new or modified commands supported for the CoS feature. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command references. There are no examples of command output for the configuration commands, because they typically do not generate output. The following commands are described here:

- class
- show tag-switching cos-map
- show tag-switching interfaces
- show tag-switching prefix-map
- tag-switching atm multi-vc
- tag-switching cos-map

In Cisco IOS Release 12.0(1)T or later, you can search and filter the output for **show** and **more** commands. This functionality is useful if you must 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** or **more** 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 atm vc** command in which you want the command output to begin with the first line where the expression "PeakRate" appears:

show atm vc | 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*.

Command Conventions

boldface font	Commands and keywords are in **boldface**.
italic font	Arguments for which you supply values are in *italics*. In contexts that do not allow *italics*, arguments are enclosed in **angle brackets** < >.
[ ]	Elements in square **brackets** are optional.
{ **x** | **y** | **z** }	Required alternative keywords are grouped in **braces** and separated by vertical bars.
{ **x** | **y** | **z**]	Required alternative keywords are grouped in **brackets** and separated by vertical bars.

class

To configure an MPLS CoS map which specifies how classes map to label VCs (LVCs) when combined with a prefix map, use the **class** cos-map submode command. To disable this option, use the **no** form of this command.

class *class* [*available standard premium control*]

no class *class* [*available standard premium control*]

Syntax Description

class	The precedence of identified traffic to classify traffic.
available	Means low precedence (In/Out plus lower two bits = 0,4).
standard	Means next precedence (In/Out plus lower two bits = 1,5).
premium	Means high precedence (In/Out plus lower two bits = 2,6).
control	Means highest precedence pair (In/Out plus lower two bits = 3,7). These bits are reserved for control traffic.

Default

No default behavior or values.

Command Mode

CoS map submode

Command History

Release	Modification
12.0(5)T	This command was introduced.

Example

The following commands configure a CoS map:

```
Router(config)# tag-switching cos-map 55
Router(config-tag-cos-map)# class 1 premium
Router(config-tag-cos-map)# exit
```

Related Commands

Command	Description
tag-switching cos-map	Configures a class map, which specifies how classes map to LVCs when combined with a prefix map.
show tag-switching cos-map	Displays a CoS map.

tag-switching prefix-map	Configures a router to use a specific CoS map for a specified destination.
access-list	Establishes MAC address access lists.

show tag-switching cos-map

To display the CoS map used to assign quantity of label VCs and associated class of service of those LVCs, use the **show tag-switching cos-map** EXEC command.

show tag-switching cos-map

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)T	This command was introduced.

Example

The following example shows output from this command:

```
Router# show tag-switching cos-map
cos-map 2    class  tag-VC
             3      control
             2      control
             1      available
             0      available
```

Table 5 lists the fields displayed.

Table 5 Show Tag-Switching Cos-Map Field Descriptions

Field	Description
cos-map	Configures a class map, which specifies how classes map to MPLS VCs when combined with a prefix map.
class	The IP precedence.
tag-VC	An ATM virtual circuit that is set up through ATM LSR label distribution procedures.

Related Commands

Command	Description
class	Enters the cos-map submode.
tag-switching cos-map	Configures a class map.

show tag-switching interfaces

To display information about one or more interfaces with the MPLS feature enabled, use the **show tag-switching interfaces** EXEC command.

show tag-switching interfaces [*interface*] [**detail**]

Syntax Description

interface	Optional. The interface about which to display MPLS information.
detail	Optional. Displays information in long form.

Default

No default behavior or values.

Command Modes

EXEC

Command History

Release	Modification
11.1 CT	This command was introduced.

Usage Guidelines

You can show information about the requested interface or about all interfaces on which the MPLS feature is enabled.

Example

The following example shows the interface in multi-VC LVC mode

```
Router# show tag-switching interfaces detail

Interface ATM3/0/0.1:
        IP tagging enabled
        TSP Tunnel tagging not enabled
        Tagging operational
        Tagswitching feature vector
        MTU = 4470
        ATM tagging: Tag VPI = 1, Control VC = 0/32, multi-vc tag-vc mode
```

Table 6 lists the fields displayed in this example.

Table 6 Show Tag-Switching Interfaces Field Descriptions

Field	Description
Interface	Interface type and number
IP tagging enabled	Status of IP MPLS on an interface.
TSP Tunnel tagging not enabled	Status of tag tsp-tunnels on the interface.
Tagging operational	Operational status of MPLS on an interface.
Tagswitching feature vector	Specifies the MPLS feature vector on an interface.
MTU	Maximum number of data bytes per labeled packet that will be transmitted.
ATM tagging	The interface uses TC-ATM procedures.

Related Command

Command	Description
tag-switching ip interface	Enables MPLS on an interface.

show tag-switching prefix-map

To show the prefix map used to assign a CoS map to network prefixes matching a standard IP access list, use the **show tag-switching prefix-map** EXEC command.

show tag-switching prefix-map [*prefix-map*]

Syntax Description

prefix-map	Specifies the prefix-map number.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)T	This command was introduced.

Example

The following is sample output from the **show tag-switching prefix-map** command:

```
Router# show tag-switching prefix-map
prefix-map 2 access-list 2 cos-map 2
```

Table 7 lists the fields displayed.

Table 7 show tag-switching prefix-map Field Description

Field	Description
prefix-map	Unique number of a prefix map.
access-list	Unique number of an access list.
cos- map	Unique number of a CoS map.

Related Command

Command	Description
tag-switching prefix-map	Configures a router to use a specified CoS map.

tag-switching atm multi-vc

To configure a router subinterface to create one or more label-VCs over which packets of different classes are sent, use the **tag-switching atm multi-vc** ATM subinterface submode command. To disable this option, use the **no** form of this command.

tag-switching atm multi-vc

no tag-switching atm multi-vc

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

ATM subinterface submode

Command History

Release	Modification
12.0(5)T	This command was introduced.

Usage Guidelines

This option is valid only on ATM MPLS subinterfaces.

Sample Display

The following commands configure interface a2/0/0.1 on the router for MPLS CoS multi-VC mode.

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# int a2/0/0.1 tag-switching
Router(config-subif)# tag atm multi-vc
Router(config-subif)# exit
Router(config)# exit
```

tag-switching cos-map

To create a class map that specifies how classes map to label-VCs when combined with a prefix map, use the **tag-switching cos-map** global configuration command.

tag-switching cos-map *number*

Syntax Description

number	Unique number for a CoS map (1 to 255).

Default

No default behavior or values.

Command Mode

Global configuration

Command History

Release	Modification
12.0(5)T	This command was introduced.

Example

This example shows how to create a class map.

```
Router(config)# tag-switching cos-map 55
Router(config-tag-cos-map)# class 1 premium
Router(config-tag-cos-map)# exit
```

Related Command

Command	Description
class	Enters the cos-map submode. The numbers you assign to the CoS map range from 0 to 3. The options are • available • control • premium • standard
show tag cos-map	Specifies CoS maps created on a router.

tag-switching prefix-map

To configure a router to use a specified CoS map when a label destination prefix matches the specified access-list, use the **tag-switching prefix-map** ATM subinterface command.

tag-switching prefix-map *prefix-map* **access-list** *access-list* **cos-map** *cos-map*

Syntax Description

prefix-map	A unique number for a prefix map.
access-list *access list*	A unique number for a simple IP access list.
cos-map *cos-map*	A unique number for a CoS map.

Default

No default behavior or values.

Command Mode

ATM subinterface submode

Command History

Release	Modification
12.0(5)T	This command was introduced.

Usage Guidelines

This is a global command used to link an access list to a CoS map.

Example

The following example links an access list to a CoS map:

```
Router(config-subif)# tag-switching prefix-map 55 access-list 55 cos-map 55
```

Related Command

Command	Description
show tag prefix-map	Shows prefix maps on a router.

Debug Commands

This section documents a new debug command. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command references.

- **debug tag-switching atm-cos**

debug tag-switching atm-cos

To display ATM label-VC bind or request activity based on the configuration of a CoS map, use the **debug tag-switching atm-cos** ATM subinterface command.

debug tag-switching atm-cos [*bind* | *request*]

Syntax Description

bind	Specifies debug information about bind responses for a vc path.
request	Specifies debug information about bind requests for a vc path.

Default

No default behavior or values.

Command Mode

ATM subinterface submode

Command History

Release	Modification
12.0(5)T	This command was introduced.

Example

```
Router# show tag forwarding
Local  Outgoing    Prefix           Bytes tag  Outgoing   Next Hop
tag    tag or VC   or Tunnel Id     switched   interface
26     28          17.17.17.17/32   0          PO6/0      point2point
27     Pop tag     11.11.11.11/32   1560       PO6/0      point2point
28     27          16.16.16.16/32   0          PO6/0      point2point
29     30          92.0.0.0/8       0          PO6/0      point2point
30     Pop tag     95.0.0.0/8       2600       PO6/0      point2point
31     2/34        10.10.10.10/32   0          AT2/0.1    point2point
32     Pop tag     14.14.14.14/32   0          Fa5/0      91.0.0.1
33     Pop tag     90.0.0.0/8       0          Fa5/0      91.0.0.1
34     Pop tag     96.0.0.0/8       0          Fa5/0      91.0.0.1
       2/36        96.0.0.0/8       0          AT2/0.1    point2point
35     35          93.0.0.0/8       0          PO6/0      point2point
36     36          12.12.12.12/32   0          PO6/0      point2point
37     37          15.15.15.15/32   0          PO6/0      point2point
38     37          18.18.18.18/32   0          Fa5/0      91.0.0.1
39     39          97.0.0.0/8       540        PO6/0      point2point
40     40          98.0.0.0/8       0          PO6/0      point2point
```

```
Router# debug tag atm-c
Router# debug tag atm-cos ?
  bind     Bind response for VC path
  request  Requests for VC binds path

Router# debug tag atm-cos bind
ATM TAGCOS Bind response debugging is on

Router# debug tag atm-cos request
ATM TAGCOS VC requests debugging is on


Router# conf t

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# int a2/0.1
Router(config-subif)# tag atm multi
Router(config-subif)# end
Router#
19:59:14:%SYS-5-CONFIG_I:Configured from console by console
Router#
19:59:24:TAGCOS-REQ:vc request 10.10.10.10/32, available
19:59:24:TAGCOS-REQ:vc request 10.10.10.10/32, standard
19:59:24:TAGCOS-REQ:vc request 10.10.10.10/32, premium
19:59:24:TAGCOS-REQ:vc request 10.10.10.10/32, control
19:59:24:TAGCOS-REQ:vc request 96.0.0.0/8, available
19:59:24:TAGCOS-REQ:vc request 96.0.0.0/8, standard
19:59:24:TAGCOS-REQ:vc request 96.0.0.0/8, premium
19:59:24:TAGCOS-REQ:vc request 96.0.0.0/8, control
TAGCOS-REQ/TCATM:11.11.11.11/32,len=4352,band=1099528405504,class=0x700
TAGCOS-REQ/TCATM:12.12.12.12/32,len=4352,band=2199040033280,class=0x700
TAGCOS-REQ/TCATM:13.13.13.13/32,len=4352,band=3298551661056,class=0x700
TAGCOS-REQ/TCATM:14.14.14.14/32,len=4352,band=4398063288832,class=0x700
TAGCOS-REQ/TCATM:15.15.15.15/32,len=4352,band=5497574916608,class=0x700
TAGCOS-REQ/TCATM:16.16.16.16/32,len=4352,band=6597086544384,class=0x700
TAGCOS-REQ/TCATM:17.17.17.17/32,len=4352,band=7696598172160,class=0x700
TAGCOS-REQ/TCATM:18.18.18.18/32,len=4352,band=8796109799936,class=0x700
TAGCOS-REQ/TCATM:90.0.0.0/8,len=768,band=3940649674539009,class=0x2
TAGCOS-REQ/TCATM:91.0.0.0/8,len=768,band=3940649674604545,class=0x2
TAGCOS-REQ/TCATM:92.0.0.0/8,len=768,band=3940649674670081,class=0x2
TAGCOS-REQ/TCATM:93.0.0.0/8,len=768,band=3940649674735617,class=0x2
TAGCOS-REQ/TCATM:94.0.0.0/8,len=768,band=3940649674801153,class=0x2
TAGCOS-REQ/TCATM:95.0.0.0/8,len=768,band=3940649674866689,class=0x2
TAGCOS-REQ/TCATM:97.0.0.0/8,len=768,band=3940649674932225,class=0x2
TAGCOS-REQ/TCATM:98.0.0.0/8,len=768,band=3940649674997761,class=0x2
TAGCOS-BIND:binding_ok 10.10.10.10/32,VCD=41 - control 41,41,41,41
TAGCOS-BIND:binding_ok 10.10.10.10/32, Inform TFIB pidx=0, in_tag=31, idx=0x80000000
TAGCOS-BIND:binding_ok 96.0.0.0/8,VCD=42 - control 42,42,42,42
TAGCOS-BIND:binding_ok 96.0.0.0/8, Inform TFIB pidx=1, in_tag=34, idx=0x80000001
TAGCOS-BIND:binding_ok 10.10.10.10/32,VCD=43 - premium 43,43,43,41
TAGCOS-BIND:binding_ok 96.0.0.0/8,VCD=44 - premium 44,44,44,42
TAGCOS-BIND:binding_ok 10.10.10.10/32,VCD=45 - standard 45,45,43,41
TAGCOS-BIND:binding_ok 96.0.0.0/8,VCD=46 - standard 46,46,44,42
TAGCOS-BIND:binding_ok 10.10.10.10/32,VCD=47 - available 47,45,43,41
TAGCOS-BIND:binding_ok 96.0.0.0/8,VCD=48 - available 48,46,44,42
72k-41-5#
72k-41-5#
```

Related Commands

Command	Description
debug tag atm-tdp	debugs label-controlled ATM tdp.
debug tag packets	debugs tag switching packets.
debug tag tdp	debugs tag distribution protocol items and information.

Glossary

AIP—ATM Interface Processor. ATM interface for Cisco 7000 series routers designed to minimize performance bottlenecks at the user-network interface (UNI).

Alien Port Adapter—Dual-wide port adapter for the Cisco 7200 router. The Alien port adapter is ABR-ready and supports traffic shaping.

ATM-LSR—A label switch router with a number of LSC-ATM interfaces. The router forwards the cells among these interfaces using labels carried in the VPI/VCI field.

ATM edge LSR—A router that is connected to the ATM-LSR cloud through LSC-ATM interfaces. The ATM edge LSR adds labels to unlabeled packets and strips labels from labeled packets.

ATM Lite—Entry-level port adapter (higher performance than the AIP) for Cisco 7500 and 7200 routers. The ATM Lite does not support traffic shaping or ABR.

CAR—Committed Access Rate (packet classification). CAR is the main feature supporting packet classification. CAR uses the type of service (TOS) bits in the IP header to classify packets. You can use the CAR classification commands to classify and reclassify a packet.

CoS—Class of service. A feature that provides scalable, differentiated types of service across an MPLS network.

DWFQ—VIP-Distributed WFQ.

DWRED—VIP-Distributed WRED.

IP Precedence—3-bit value in TOS byte used for assigning precedence to IP packets.

label—A short fixed-length label that tells switching nodes how the data (packets or cells) should be forwarded.

label imposition—The act of putting the first label on a packet.

Label Switch—A node that forwards units of data (packets or cells) on the basis of labels.

Label Switching Router (LSR)—A Layer 3 router that forwards a packet based on the value of a label encapsulated in the packet.

Label VC (LVC)—An ATM virtual circuit that is set up through ATM LSR label distribution procedures.

label-controlled ATM interface (LC-ATM interface)—An interface on a router or switch that uses label distribution procedures to negotiate label VCs.

LBR—Label Bit Rate. Service category defined by this document for label-VC traffic. Link and per-VC bandwidth sharing may be controlled by relative bandwidth configuration at the edge and each switch along a label-VC. No ATM traffic-related parameters specified.

MPLS—Multiprotocol Label Switching. An emerging industry standard.

QoS—Quality of service. Measure of performance for a transmission system that reflects its transmission quality and service availability.

RED—Random early detection. Congestion avoidance algorithm in which a small percentage of packets are dropped when congestion is detected and before the queue in question overflows completely.

TOS—Type of Service. A byte in the IPv4 header.

VPN—Virtual private network. Enables IP traffic to use tunneling to travel securely over a public TCP/IP network.

WEPD—Weighted Early Packet Discard

WRED—Weighted RED. A variant of RED in which the probability of a packet being dropped depends on either, its IP Precedence, CAR marking, or MPLS CoS (as well as the other factors in the RED algorithm).

WFQ—Weighted Fair Queueing. A queue management algorithm that provides a certain fraction of link bandwidth to each of several queues, based on a relative bandwidth applied to each of the queues.