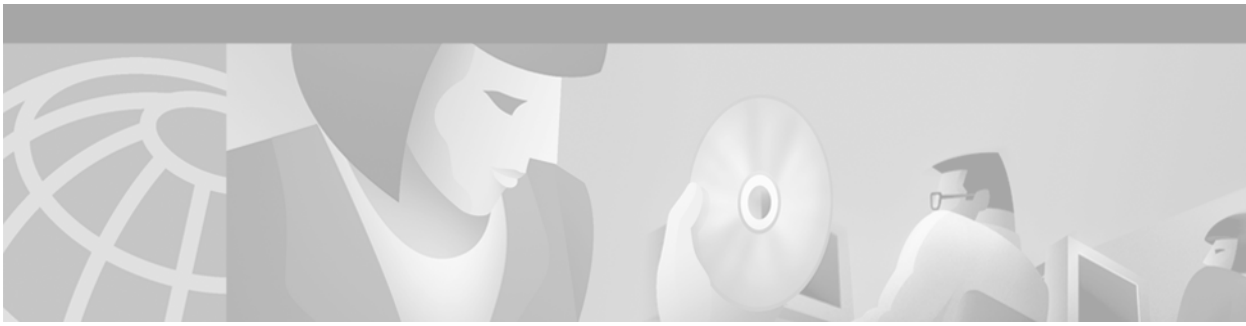


ATM PVC Bundle Enhancement — MPLS EXP-Based PVC Selection

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes the ATM PVC Bundle Enhancement — MPLS EXP-Based PVC Selection feature in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

The ATM PVC Bundle Enhancement — MPLS EXP-Based PVC Selection feature is an extension to the IP to ATM Class of Service feature suite. The IP to ATM Class of Service feature suite, using virtual circuit (VC) support and bundle management, maps quality of service (QoS) characteristics between IP and ATM. It provides customers who have multiple VCs (with varying qualities of service to the same destination) the ability to build a QoS differentiated network.

The IP to ATM Class of Service feature suite allowed customers to use IP precedence level as the selection criteria for packet forwarding. This new feature now gives customers the option of using the Multiprotocol Label Switching (MPLS) experimental (EXP) level as an additional selection criteria for packet forwarding.

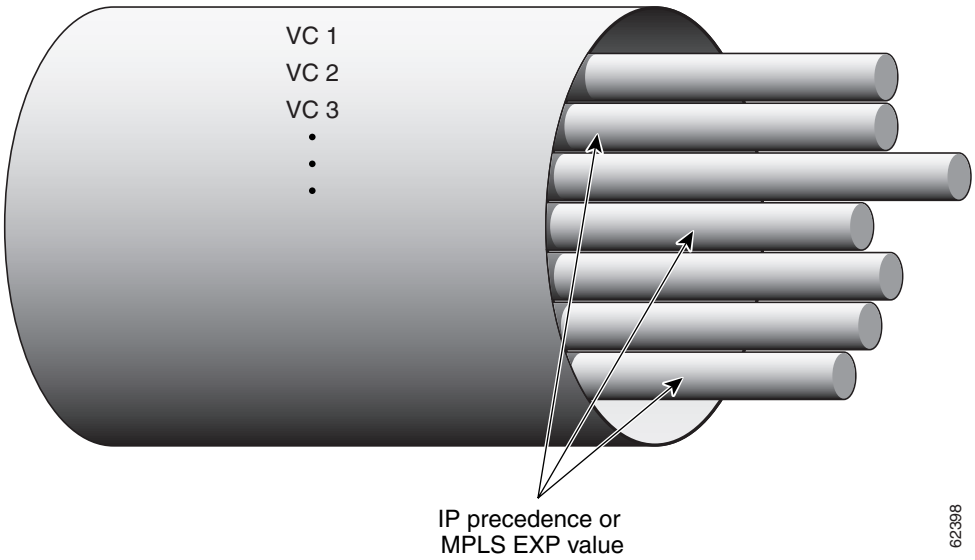
Note If a selection criteria for packet forwarding is not selected (that is, if the packet is unlabeled), this new feature uses the IP precedence level as the default selection criteria.

For more information about the IP to ATM Class of Service feature suite, refer to the "Configuring IP to ATM Class of Service" chapter of the *Cisco IOS Quality of Service Solutions Configuration Guide,* Release 12.2.

VC Bundle Support and Bundle Management

ATM VC bundle management allows you to configure multiple VCs that have different QoS characteristics between any pair of ATM-connected routers. As shown in Figure 1, these VCs are grouped in a bundle and are referred to as bundle members.

Figure 1 ATM VC Bundle

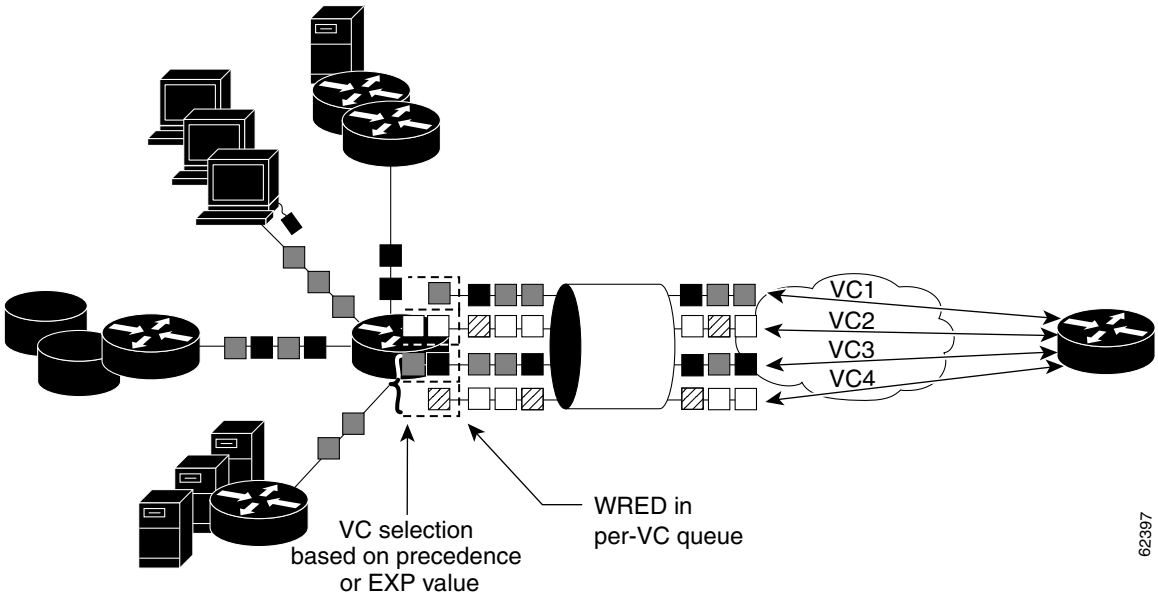


ATM VC bundle management allows you to define an ATM VC bundle and add VCs to it. Each VC of a bundle has its own ATM traffic class and ATM traffic parameters. You can apply attributes and characteristics to discrete VC bundle members, or you can apply them collectively at the bundle level.

Using VC bundles, you can create differentiated service by flexibly distributing MPLS EXP levels over the different VC bundle members. You can map a single MPLS EXP level, or a range of these levels, to each discrete VC in the bundle, thereby enabling individual VCs in the bundle to carry packets marked with different MPLS EXP levels. You can use Weighted Random Early Detection (WRED) or distributed WRED (dWRED) to further differentiate service across traffic that has different MPLS EXP levels.

To determine which VC in the bundle to use to forward a packet to its destination, the ATM VC bundle management software matches MPLS EXP levels between packets and VCs (see Figure 2). IP traffic is sent to the next hop address for the bundle because all VCs in a bundle share the same destination, but the VC used to carry a packet depends on the value set for that packet in the MPLS EXP level of the type of service (ToS) byte of its header. The ATM VC bundle management software matches the MPLS EXP level of the packet to the MPLS EXP levels assigned to a VC, sending the packet out on the appropriate VC. Moreover, the ATM VC bundle management software allows you to configure how traffic will be redirected when the VC to which the packet was initially directed goes down. Figure 2 illustrates how the ATM VC bundle management software determines which permanent virtual circuit (PVC) bundle member to use to carry a packet and how WRED (or dWRED) is used to differentiate traffic on the same VC.

Figure 2 ATM VC Bundle PVC Selection for Packet Transfer



The support of multiple parallel ATM VCs allows you to create stronger service differentiation at the IP layer. For instance, you might want to configure the network to provide IP traffic belonging to real-time class of service (CoS) (such as Voice over IP traffic) on an ATM VC with strict constraints (constant bit rate (CBR) or variable bit rate real-time (VBR-rt), for example), while also allowing the network to transport nonreal-time traffic over a more elastic ATM unspecified bit rate (UBR) PVC. UBR is effectively the ATM version of best-effort service. Using a configuration such as this would allow you to make full use of your network capacity.

Benefits

Improved System Performance

This feature is designed to provide a true working solution to class-based services, without the investment of new ATM network infrastructures. Now networks can offer different service classes (sometimes termed *differential service classes*) across the entire WAN, not just the routed portion. Mission-critical applications can be given exceptional service during periods of high network usage and congestion. In addition, noncritical traffic can be restricted in its network usage, ensuring greater QoS for more important traffic and user types.

Additional Selection Criteria

This new feature now gives customers the option of using the MPLS EXP level, in addition to IP precedence, as a selection criteria for packet forwarding.

Restrictions

- This feature requires ATM PVC management, as well as Forwarding Information Base (FIB) and Tag Forwarding Information Base (TFIB) switching functionality.
- This feature is not supported on either the ATM interface processor (AIP) or the ATM Lite port adapter (PA-A1).
- The router at the remote end of the network must be using a version of Cisco IOS that supports MPLS and ATM PVC management.

Related Features and Technologies

This feature is similar to the IP to ATM Class of Service feature suite, which is documented in the "Configuring IP to ATM Class of Service" chapter of the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2.

Related Documents

- *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2
- *Cisco IOS Switching Services Configuration Guide*, Release 12.2
- *Cisco IOS Switching Services Command Reference*, Release 12.2
- *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2
- *Cisco IOS Wide-Area Networking Command Reference*, Release 12.2
- *IP to ATM SVC Bundles for Class of Service (CoS) Mapping*, Cisco IOS Release 12.2(4)T feature module
- *MPLS Label Distribution Protocol*, Cisco IOS Release 12.2(4)T feature module

Supported Platforms

- Cisco 3600 series

  The ATM Adapter PA-A3 is not supported on either the Cisco 3620 router or the Cisco 3640 router. Because certain QoS features (for example, WRED) require the ATM Adapter PA-A3, specific limitations may apply. For more information about platform and feature support, refer to Cisco Feature Navigator (described below).
- Cisco 3725
- Cisco 3745
- Cisco 7200 series
- Cisco 7500 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

http://www.cisco.com/go/fn

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new or modified RFCs are supported by this feature.

Configuration Tasks

See the following sections for configuration tasks for the ATM PVC Bundle Enhancement — MPLS EXP-Based PVC Selection feature. Each task in the list is identified as either required or optional.

- Enabling MPLS (required)
- Creating a VC Bundle (required)
- Applying Parameters to Bundles (required)
  - Configuring Bundle-Level Parameters (required)
  - Configuring a VC Bundle Member Directly (optional)
  - Configuring VC Class Parameters to Apply to a Bundle (optional)
  - Attaching a Class to a Bundle (optional)
- Verifying the Configuration (optional)

Enabling MPLS

To enable MPLS, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip cef`	Enables Cisco Express Forwarding (CEF) on the Route Processor (RP) card. An optional keyword **distributed** can be used with this command to enable distributed CEF (dCEF) for the Versatile Interface Processor (VIP)-based platforms.
Step 2	`Router(config)# mpls label protocol ldp`	Specifies the default label distribution protocol for a platform.
Step 3	`Router(config)# interface` *type number* [*name-tag*]	Configures an interface type and enters interface configuration mode.
Step 4	`Router(config-if)# mpls ip`	Enables MPLS forwarding of IPv4 packets along normally routed paths for the platform.

Creating a VC Bundle

To create a bundle and enter bundle configuration mode in which you can assign attributes and parameters to the bundle and to all of its member VCs, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# bundle` *bundle-name*	Creates the specified bundle and enters bundle configuration mode.

Applying Parameters to Bundles

Parameters (or attributes) can be applied to bundles either by applying the parameters directly to the bundle or by applying the parameters to a VC class assigned to the bundle.

Applying parameters by using VC classes assigned to the bundle allows you to apply multiple parameters at once because you apply the VC class to the bundle and to all of its VC members. This method allows you to apply a parameter across all VCs for the bundle, after which (for some parameters) you can later modify that parameter for individual VCs. After configuring the parameters for the VC class, you need to attach the VC class to the bundle.

Parameters applied directly to a bundle take priority over those applied to VC classes assigned to the bundle. Parameters applied to VC classes assigned to the bundle take priority over those applied to individual VCs.

Note Note that some parameters applied through a VC class or directly to the bundle can be superseded by commands that you directly apply to individual VCs in bundle-vc configuration mode.

To begin applying parameters to bundles, complete the procedure in the section "Configuring Bundle-Level Parameters."

Configuring Bundle-Level Parameters

To begin configuring parameters that apply to the bundle and to all of its members, use the following commands in bundle configuration mode, as needed:

Command	Purpose
`Router(config-if-atm-bundle)# protocol` *protocol* {*protocol-address* | **inarp**} [[**no**] **broadcast**]	Configures a static map or enables Inverse Address Resolution Protocol (Inverse ARP) or Inverse ARP broadcasts for the bundle.
`Router(config-if-atm-bundle)# encapsulation` *aal-encap*	Configures the ATM adaptation layer (AAL) and encapsulation type for the bundle.

What's Next?

Next, decide if you want to configure the VC bundle member directly or use a VC class attached to a bundle. To configure the VC bundle member directly, complete just the procedure in the "Configuring a VC Bundle Member Directly" section. To use a VC class attached to a bundle, instead complete the procedures in both the "Configuring VC Class Parameters to Apply to a Bundle" section and the "Attaching a Class to a Bundle" section.

Configuring a VC Bundle Member Directly

To configure an individual VC bundle member directly, use the following commands in bundle-vc configuration mode, as needed. To enter bundle-vc configuration mode, use the **pvc-bundle** command.

Command	Purpose
`Router(config-if-atm-member)# ubr output-pcr [input-pcr]`	Configures the VC for UBR QoS and specifies the output peak cell rate (PCR) for it.
`Router(config-if-atm-member)# vbr-nrt output-pcr output-scr output-mbs [input-pcr] [input-scr] [input-mbs]`	Configures the VC for variable bit rate nonreal-time (VBR-nrt) QoS and specifies the output PCR, output sustainable cell rate, and output maximum burst cell size for it.
`Router(config-if-atm-member)# mpls experimental [other | range]`	Configures the MPLS EXP levels for the VC.
`Router(config-if-atm-member)# bump {implicit | explicit precedence-level | traffic}`	Configures the bumping rules for the VC.
`Router(config-if-atm-member)# protect {group | vc}`	Configures the VC to belong to the protected group of the bundle or to be an individually protected VC bundle member.

Configuring VC Class Parameters to Apply to a Bundle

To configure a VC class to contain commands that configure all VC members of a bundle when the class is applied to that bundle, use the following command in vc-class configuration mode. To enter vc-class configuration mode, use the **vc-class atm** command.

Command	Purpose
`Router(config-vc-class)# oam-bundle [manage] [frequency]`	Enables end-to-end F5 Operation, Administration, and Maintenance (OAM) loopback cell generation and OAM management for all VCs in the bundle.

In addition to the **oam-bundle** command, you can add the following commands to a VC class to be used to configure a bundle: **broadcast**, **encapsulation**, **inarp**, **oam retry**, and **protocol**. For information on these commands, including configuration tasks and command syntax, refer to the *Cisco IOS Wide-Area Networking Configuration Guide,* Release 12.2 and the *Cisco IOS Wide-Area Networking Command Reference*, Release 12.2.

Note If you are using a VC class to configure the bundle, you must attach the VC class to the bundle. To do this, complete the procedure in the section "Attaching a Class to a Bundle."

Attaching a Class to a Bundle

To attach a VC class containing bundle-level configuration commands to a bundle, use the following command in bundle configuration mode. To enter bundle configuration mode, use the **bundle** command.

Command	Purpose
`Router(config-if-atm-bundle)# class-bundle vc-class-name`	Configures a bundle with the bundle-level commands contained in the specified VC class.

Verifying the Configuration

To verify the configuration of the feature, use the following commands in EXEC mode, as needed:

Command	Purpose
`Router# debug atm bundle error`	Displays debug messages for PVC bundle errors.
`Router# debug atm bundle events`	Displays PVC bundle events.
`Router# show atm map`	Displays the list of all configured ATM static maps to remote hosts on an ATM network.
`Router# show atm bundle bundle-name`	Displays the bundle attributes assigned to each VC member and the current working status of the VC members.
`Router# show mpls forwarding-table`	Displays the contents of the MPLS FIB.

Configuration Examples

This section provides the following configuration example:

- VC Bundle Configuration Using a VC Class Example

VC Bundle Configuration Using a VC Class Example

This example configures VC bundle management on a router that uses Intermediate System-to-Intermediate System (IS-IS) as its IP routing protocol.

Bundle-Class Class

At the outset, this configuration defines a VC class called “bundle-class,” which includes commands that set VC parameters. When the class bundle-class is applied at the bundle level, these parameters are applied to all VCs that belong to the bundle. Note that any commands applied directly to an individual VC of a bundle in bundle-vc mode take precedence over commands applied globally at the bundle level.

Taking into account hierarchy precedence rules, VCs belonging to any bundle to which the class bundle-class is applied will be characterized by the following parameters: aal5snap encapsulation, broadcast on, use of Inverse ARP to resolve IP addresses, and OAM enabled.

```
router isis
 net 49.0000.0000.0000.1111.00

vc-class atm bundle-class
 encapsulation aal5snap
 broadcast
 protocol ip inarp
 oam-bundle manage 3
 oam 4 3 10
```

The following four sections of the configuration define specific VC classes. Each of these classes contains commands used to specify parameters that can then be applied to individual VCs in a bundle by assigning the class to that VC.

Control-Class Class

When the class called “control-class” is applied to a VC, the VC carries traffic whose MPLS EXP level is 7. When the VC to which this class is assigned goes down, it takes the bundle down with it because this class makes the VC a protected one. The QoS type of a VC using this class is vbr-nrt.

```
vc-class atm control-class
 mpls experimental 7
 protect vc
 vbr-nrt 1000 5000 32
```

Premium-Class Class

When the class called “premium-class” is applied to a VC, the VC carries traffic whose MPLS EXP levels are 6 and 5. The VC does not allow other traffic to be bumped onto it. When the VC to which this class is applied goes down, its bumped traffic will be redirected to a VC whose MPLS EXP level is 7. This class makes a VC a member of the protected group of the bundle. When all members of a protected group go down, the bundle goes down. The QoS type of a VC using this class is vbr-nrt.

```
vc-class atm premium-class
 mpls experimental 6-5
 no bump traffic
 protect group
 bump explicitly 7
 vbr-nrt 20000 10000 32
```

Priority-Class Class

When the class called “priority-class” is applied to a VC, the VC is configured to carry traffic with an MPLS EXP level in the 4 – 2 range. The VC uses the implicit bumping rule, it allows traffic to be bumped, and it belongs to the protected group of the bundle. The QoS type of a VC using this class is ubr+.

```
vc-class atm priority-class
 mpls experimental 4-2
 protect group
 ubr+ 10000 3000
```

Basic-Class Class

When the class called "basic-class" is applied to a VC, the VC is configured through the **mpls experimental other** command to carry traffic with MPLS EXP levels not specified in the profile. The VC using this class belongs to the protected group of the bundle. The QoS type of a VC using this class is ubr.

```
vc-class atm basic-class
 mpls experimental other
 protect group
 ubr 10000
```

The following sets of commands configure three bundles that the router subinterface uses to connect to three of its neighbors. These bundles are called "new-york," "san-francisco," and "los-angeles." Bundle new-york has four VC members, bundle san-francisco has four VC members, and bundle los-angeles has three VC members.

new-york Bundle

The first part of this example specifies the IP address of the subinterface, the router protocol—the router uses IS-IS as an IP routing protocol—and it creates the first bundle called "new-york" and enters bundle configuration mode:

```
interface a1/0.1 multipoint
 ip address 10.0.0.1 255.255.255.0
 ip router isis
 bundle new-york
```

From within bundle configuration mode, the next portion of the configuration uses two protocol commands to enable IP and Open Systems Interconnect (OSI) traffic flows in the bundle. The OSI routing packets will use the highest MPLS EXP VC in the bundle. The OSI data packets, if any, will use the lowest MPLS EXP VC in the bundle. If configured, other protocols, such as Internet Packet Exchange (IPX) or AppleTalk, will always use the lowest MPLS EXP VC in the bundle.

As the indentation levels of the preceding and following commands suggest, subordinate to bundle new-york is a command that configures its protocol and a command that applies the class called "bundle-class" to it.

```
  protocol ip 1.1.1.2 broadcast
  protocol clns 49.0000.0000.2222.00 broadcast
  class-bundle bundle-class
```

The class called "bundle-class," which is applied to the bundle new-york, includes a **protocol ip inarp** command. According to inheritance rules, **protocol ip**, configured at the bundle level, takes precedence over **protocol ip inarp** specified in the class bundle-class.

The next set of commands beginning with **pvc-bundle ny-control 207**, which are further subordinate, add four VCs (called "ny-control," "ny-premium," "ny-priority," and "ny-basic") to the bundle new-york. A particular class—that is, one of the classes predefined in this configuration example—is applied to each VC to configure it with parameters specified by commands included in the class.

As is the case for this configuration, to configure individual VCs belonging to a bundle, the router must be in bundle mode for the mother bundle. For each VC belonging to the bundle, the subordinate mode is pvc-mode for the specific VC.

The following commands configure the individual VCs for the bundle new-york:

```
pvc-bundle ny-control 207
 class-vc control-class
pvc-bundle ny-premium 206
 class-vc premium-class
pvc-bundle ny-priority 204
 class-vc priority-class
pvc-bundle ny-basic 201
 class-vc basic-class
```

san-francisco Bundle

The following set of commands create and configure a bundle called "san-francisco." At the bundle configuration level, the configuration commands included in the class bundle-class are ascribed to the bundle san-francisco and to the individual VCs that belong to the bundle. Then, the **pvc-bundle** command is executed for each individual VC to add it to the bundle. After a VC is added and bundle-vc configuration mode is entered, a particular, preconfigured class is assigned to the VC. The configuration commands comprising that class are used to configure the VC. Rules of hierarchy apply at this point. Command parameters contained in the applied class are superseded by the same parameters applied at the bundle configuration level, which are superseded by the same parameters applied directly to a VC.

```
bundle san-francisco
 protocol clns 49.0000.0000.0000.333.00 broadcast
 inarp 1
 class-bundle bundle-class
 pvc-bundle sf-control 307
  class-vc control-class
 pvc-bundle sf-premium 306
  class-vc premium-class
 pvc-bundle sf-priority 304
  class-vc priority-class
 pvc-bundle sf-basic 301
  class-vc basic-class
```

los-angeles Bundle

The following set of commands create and configure a bundle called "los-angeles." At the bundle configuration level, the configuration commands included in the class bundle-class are ascribed to the bundle los-angeles and to the individual VCs that belong to the bundle. Then, the **pvc-bundle** command is executed for each individual VC to add it to the bundle. After a VC is added and bundle-vc configuration mode is entered, the MPLS EXP level is set for the VC, and the VC is either configured as a member of a protected group (protect group) or as an individually protected VC. A particular class is then assigned to each VC to further characterize it. Rules of hierarchy apply. Parameters of commands applied directly and discretely to a VC take precedence over the same parameters applied within a class to the VC at the bundle-vc configuration level, which take precedence over the same parameters applied to the entire bundle at the bundle configuration level.

```
bundle los-angeles
 protocol ip 1.1.1.4 broadcast
 protocol clns 49.0000.0000.4444.00 broadcast
 inarp 1
 class-bundle bundle-class
 pvc-bundle la-high 407
  mpls experimental 7-5
  protect vc
  class-vc premium-class
 pvc-bundle la-mid 404
  mpls experimental 4-2
```

```
 protect group
 class-vc priority-class
pvc-bundle la-low 401
 mpls experimental other
 protect group
 class-vc basic-class
```

Command Reference

This section documents new and modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.2 command reference publications or new feature documentation. For more information, see the "Related Documents" section in this document.

New Commands

- **mpls experimental**

Modified Commands

- **show mpls forwarding-table**

mpls experimental

To configure Multiprotocol Label Switching (MPLS) experimental (EXP) levels for a virtual circuit (VC) class that can be assigned to a VC bundle and thus applied to all VC members of that bundle, use the **mpls experimental** command in vc-class configuration mode. To remove the MPLS EXP levels from the VC class, use the **no** form of this command.

To configure the MPLS EXP levels for a VC member of a bundle, use the **mpls experimental** command in bundle-vc configuration mode. To remove the MPLS EXP levels from the VC, use the **no** form of this command.

mpls experimental [**other** | *range*]

no mpls experimental

Syntax Description

other	(Optional) Any MPLS EXP levels in the range from 0 to 7 that are not explicitly configured.
range	(Optional) A single MPLS EXP level specified as a number, or a range of levels, specified as a hyphenated range.

Defaults

Defaults to **other**, that is, any MPLS EXP levels in the range from 0 to 7 that are not explicitly configured.

Command Modes

VC-class configuration (for a VC class)

Bundle-vc configuration (for ATM VC bundle members)

Command History

Release	Modification
12.2(8)T	This command was introduced.

Usage Guidelines

Assignment of MPLS EXP levels to VC bundle members allows you to create differentiated service because you can distribute the MPLS EXP levels over the different VC bundle members. You can map a single level or a range of levels to each discrete VC in the bundle, thereby enabling VCs in the bundle to carry packets marked with different levels. Alternatively, you can configure a VC with the **mpls experimental other** command to indicate that it can carry traffic marked with levels not specifically configured for it. Only one VC in the bundle can be configured with the **mpls experimental other** command to carry all levels not specified. This VC is considered the default one.

To use this command in vc-class configuration mode, enter the **vc-class atm** global configuration command before you enter this command. This command has no effect if the VC class that contains the command is attached to a standalone VC, that is, if the VC is not a bundle member.

To use this command to configure an individual bundle member in bundle-vc configuration mode, first enter the **bundle** command to enact bundle configuration mode for the bundle to which you want to add or modify the VC member to be configured. Then, use the **pvc-bundle** command to specify the VC to be created or modified and enter bundle-vc configuration mode.

VCs in a VC bundle are subject to the following configuration inheritance guidelines (listed in order of next highest MPLS EXP level):

- VC configuration in bundle-vc mode
- Bundle configuration in bundle mode (with the effect of assigned vc-class configuration)
- Subinterface configuration in subinterface mode

Note If you are using an ATM interface, you must configure all MPLS EXP levels (ranging from 0 to 7) for the bundle. To do this, Cisco recommends configuring one member of the bundle with the **mpls experimental other** command. The **other** keyword defaults to any MPLS EXP levels in the range from 0 to 7 that are not explicitly configured.

Examples

The following example configures a class called "control-class" that includes a **mpls experimental** command that, when applied to a bundle, configures all VC members of that bundle to carry MPLS EXP level 7 traffic. Note, however, that VC members of that bundle can be individually configured with the **mpls experimental** command at the bundle-vc level, which would supervene.

```
vc-class atm control-class
 mpls experimental 7
```

The following example configures permanent virtual circuit (PVC) 401 (with the name of control-class) to carry traffic with MPLS EXP levels in the range of 4 – 2, overriding the level mapping set for the VC through vc-class configuration:

```
pvc-bundle control-class 401
 mpls experimental 4-2
```

Related Commands

Command	Description
bump	Configures the bumping rules for a VC class that can be assigned to a VC bundle.
class-vc	Assigns a VC class to an ATM PVC, SVC, or VC bundle member.
protect	Configures a VC class with protected group or protected VC status for application to a VC bundle member.
ubr	Configures UBR QoS and specifies the output PCR for an ATM PVC, SVC, VC class, or VC bundle member.
vbr-nrt	Configures the VBR-NRT QoS and specifies the output PCR, output sustainable cell rate, and output maximum burst cell size for an ATM PVC, SVC, VC class, or VC bundle member.

show mpls forwarding-table

To display the contents of the MPLS Forwarding Information Base (FIB), use the **show mpls forwarding-table** command in EXEC mode.

show mpls forwarding-table [{*network* {*mask* | *length*} | **labels** *label* [**-** *label*] | **interface** *interface* | **next-hop** *address* | **lsp-tunnel** [*tunnel-id*]}] [**detail**]

Syntax Description

network	(Optional) Destination network number.
mask	(Optional) IP address of the destination mask whose entry is to be shown.
length	(Optional) Number of bits in mask of destination.
labels *label* **-** *label*	(Optional) Displays only entries with the specified local labels.
interface *interface*	(Optional) Displays only entries with the specified outgoing interface.
next-hop *address*	(Optional) Displays only entries with the specified neighbor as the next hop.
lsp-tunnel *tunnel-id*	(Optional) Displays only entries with the specified label switched path (LSP) tunnel, or with all LSP tunnel entries.
detail	(Optional) Displays information in long form (includes length of encapsulation, length of MAC string, maximum transmission unit (MTU), and all labels).

Command Modes

EXEC

Command History

Release	Modification
11.1 CT	This command was introduced.
12.1(3)T	This command was modified to reflect new MPLS Internet Engineering Task Force (IETF) terminology and command-line interface (CLI) command syntax.
12.2(8)T	The command was modified to accommodate use of the MPLS experimental (EXP) level as a selection criteria for packet forwarding. The output display was modified to include a bundle adjacency field and exp (vcd) values when the optional **detail** keyword is specified.

Usage Guidelines

The optional parameters described allow specification of a subset of the entire FIB.

Examples

The following is sample output from the **show mpls forwarding-table** command:

```
Router# show mpls forwarding-table

Local Outgoing      Prefix            Bytes tag Outgoing       Next Hop
tag   tag or VC     or Tunnel Id      switched  interface
26    Untagged      10.253.0.0/16     0         Et4/0/0        172.27.32.4
28    1/33          10.15.0.0/16      0         AT0/0.1        point2point
29    Pop tag       10.91.0.0/16      0         Hs5/0          point2point
      1/36          10.91.0.0/16      0         AT0/0.1        point2point
30    32            10.250.0.97/32    0         Et4/0/2        10.92.0.7
      32            10.250.0.97/32    0         Hs5/0          point2point
34    26            10.77.0.0/24      0         Et4/0/2        10.92.0.7
      26            10.77.0.0/24      0         Hs5/0          point2point
35    Untagged  [T] 10.100.100.101/32 0         Tu301          point2point
36    Pop tag       168.1.0.0/16      0         Hs5/0          point2point
      1/37          168.1.0.0/16      0         AT0/0.1        point2point

[T]     Forwarding through a TSP tunnel.
        View additional tagging info with the 'detail' option
```

The following is sample output from the **show mpls forwarding-table** command when you specify the **detail** keyword. If the MPLS EXP level is used as a selection criterion for packet forwarding, a Bundle adjacency exp (vcd) field is included in the display. This field includes the EXP value and the corresponding virtual circuit descriptor (VCD) in parentheses.

```
Router# show mpls forwarding-table detail

Local Outgoing      Prefix            Bytes tag Outgoing       Next Hop
tag   tag or VC     or Tunnel Id      switched  interface
16    Pop tag       1.0.0.6/32        0         AT1/0.1        point2point
      Bundle adjacency exp(vcd)
      0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
      MAC/Encaps=12/12, MTU=4474, Tag Stack{}
      00010000AAAA030000008847
      No output feature configured
17    18            1.0.0.9/32        0         AT1/0.1        point2point
      Bundle adjacency exp(vcd)
      0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
      MAC/Encaps=12/16, MTU=4470, Tag Stack{18}
      00010000AAAA030000008847 00012000
      No output feature configured
18    19            1.0.0.10/32        0        AT1/0.1        point2point
      Bundle adjacency exp(vcd)
      0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
      MAC/Encaps=12/16, MTU=4470, Tag Stack{19}
      00010000AAAA030000008847 00013000
      No output feature configured
19    17            20.0.0.0/8         0        AT1/0.1        point2point
      Bundle adjacency exp(vcd)
      0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
      MAC/Encaps=12/16, MTU=4470, Tag Stack{17}
      00010000AAAA030000008847 00011000
      No output feature configured
20    20            60.0.0.0/8         0        AT1/0.1        point2point
      Bundle adjacency exp(vcd)
      0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
      MAC/Encaps=12/16, MTU=4470, Tag Stack{20}
      00010000AAAA030000008847 00014000
      No output feature configured
```

```
21     Pop tag       60.0.0.0/24        0        AT1/0.1       point2point
       Bundle adjacency exp(vcd)
       0(1) 1(1) 2(1) 3(1) 4(1) 5(1) 6(1) 7(1)
       MAC/Encaps=12/12, MTU=4474, Tag Stack{}
        00010000AAAA030000008847
       No output feature configured
22     Pop tag       1.0.0.4/32         0        Et2/3         40.0.0.4
       MAC/Encaps=14/14, MTU=1504, Tag Stack{}
        000427AD10430005DDFE043B8847
       No output feature configured
```

Table 1 describes the significant fields shown in the output.

Table 1 show mpls forwarding-table Field Descriptions

Field	Description
Local tag	Label assigned by this router.
Outgoing tag or VC	Label assigned by the next hop or virtual path identifier (VPI)/ virtual channel identifier (VCI) used to get to next hop. The entries that you can specify in this column include the following: • [T]—Means forwarding through an LSP tunnel. • "Untagged"—Means that there is no label for the destination from the next hop or that label switching is not enabled on the outgoing interface. • "Pop tag"—Means that the next hop advertised an implicit NULL label for the destination and that this router popped the top label.
Prefix or Tunnel Id	Address or tunnel to which packets with this label are going.
Bytes tag switched	Number of bytes switched with this incoming label.
Outgoing interface	Interface through which packets with this label are sent.
Next Hop	IP address of the neighbor that assigned the outgoing label.
Bundle adjacency exp (vcd)	Bundle adjacency information. Includes the MPLS EXP value and the corresponding VCD.
MAC/Encaps	Length in bytes of the Layer 2 header and length in bytes of the packet encapsulation, including the Layer 2 header and label header.
MTU	Maximum transmission unit (MTU) of the labeled packet.
Tag Stack	All the outgoing labels. If the outgoing interface is transmission convergence (TC)-ATM, the VCD is also shown.
00010000AAAA030000008847 00013000	The actual encapsulation in hexadecimal form. A space is shown between Layer 2 and the label header.