Enhanced Voice and QoS for ADSL and G.SHDSL on Cisco 1700 Series, Cisco 2600 Series, Cisco 3600 Series, and Cisco 3700 Series Routers

Feature History

Release	Modification
12.2(2)XQ	Voice and QoS features were introduced for ADSL on the Cisco 1720, Cisco 1750, and Cisco 1751. **Note** The Cisco 1720 router does not support voice.
12.2(2)XK	Voice and QoS features for ADSL were implemented on the Cisco 2610-2651 and Cisco 3600 series.
12.2(4)XL	Voice and QoS features for ADSL and G.SHDSL were implemented on the Cisco 1700 series, Cisco 2610-2651, and Cisco 3600 series.
12.2(8)YN	Voice and QoS features were further expanded for ADSL and G.SHDSL and were implemented on the Cisco 1700 series, Cisco 2610XM-2651XM, Cisco 3640, Cisco 3640A, and Cisco 3660.
12.2(13)T	Voice and QoS features for ADSL and G.SHDSL that were introduced in Cisco IOS Releases 12.2(2)XQ, 12.2(2)XK, and 12.2(4)XL were integrated into Cisco IOS Release 12.2(13)T. Cisco IOS Release 12.2(13)T provides the first available voice and QoS support for ADSL and G.SHDSL for the Cisco 2691 and Cisco 3700 series. (Features that were new to Cisco IOS Release 12.2(8)YN will be integrated into a future T-train release.)

This document describes enhancements to the voice and quality of service (QoS) features for asymmetric digital subscriber lines (ADSLs) and single-pair high-bit-rate digital subscriber lines (G.SHDSLs) on the Cisco 1700 series, Cisco 2600 series, Cisco 3600 series, and Cisco 3700 series. This document includes the following sections:

Feature Overview

Cisco 1700 series, Cisco 2600 series, Cisco 3600 series, and Cisco 3700 series routers with ADSL or G.SHDSL WAN interface cards (WICs) support the integration of voice and data over the same ADSL or G.SHDSL circuit using Voice over IP (VoIP). The Cisco 2600 series, Cisco 3600 series, and Cisco 3700 series routers with ADSL or G.SHDSL WICs also support the integration of voice and data over the same ADSL or G.SHDSL circuit using Voice over ATM (VoATM).

Note

- To configure these voice and QoS features, you must first install and configure an ADSL or G.SHDSL WIC on your Cisco 1700 series, Cisco 2600 series, Cisco 3600 series, or Cisco 3700 series router. Refer to the installation and configuration instructions in the following documents:
  - *Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers*
  - *Installing the G.SHDSL ATM WIC on the Cisco 1700 Series Router*
  - *1-Port ADSL ATM WAN Interface Card for Cisco 2600 Series and 3600 Series Routers*, Release 12.2(4)T
  - *1-Port G.SHDSL WAN Interface Card for Cisco 2600 Series and 3600 Series Routers*, Release 12.2(4)XL
  - *ADSL WAN Interface Card for the Cisco 2600/3600/3700 Series*
  - *G.SHDSL WAN Interface Card for the Cisco 2600/3600/3700 Series*

QoS features make it possible to effectively combine voice and data traffic in the same WAN connection without sacrificing quality and reliability. Service providers can increase revenue by building differentiated service options based on premium, standard, or best-effort service classes.

The following voice and QoS features are supported on ADSL and G.SHDSL WICs. The new features introduced in Cisco IOS Release 12.2(8)YN are marked with an asterisk (*).

- Classification and Marking
  - ATM CLP Bit Marking *
  - Class-Based Packet Marking with Differentiated Services
  - Committed Access Rate
  - Dial-Peer DSCP and IP Precedence Marking
  - Local Policy Routing
  - Network-Based Application Recognition
  - Policy-Based Routing
- Queueing and Scheduling
  - Class-Based Weighted Fair Queueing
  - Low Latency Queueing
  - Per-VC Queueing

- Congestion Avoidance
  - Class-Based Weighted Random Early Detection with DSCP (egress)
  - Resource Reservation Protocol
  - Weighted Random Early Detection
- Policing and Traffic Shaping
  - ATM Traffic Shaping
  - Class-Based Policing
  - Traffic Policing
  - VC Shaping for Variable Bit Rate-Nonreal Time
- Link Efficiency
  - cRTP over an ATM Link with PPP Encapsulation *
  - Link Fragmentation and Interleaving
  - MLP Bundling *
  - PPPoE MTU Adjustment
  - Tunable Transmission Ring *
  - VC Bundling
- Other (IP QoS)
  - Access Control Lists
  - IP QoS Map to ATM Class of Service
- Additional Supported Features
  - Analog Voice Interface Support (requires an appropriate voice interface card [VIC])
  - Clock Rate for AAL5 and AAL2 *
  - Concurrent VoIP and VoATM (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)
  - F5 OAM CC Segment Functionality
  - FRF.5 and FRF.8 *
  - H.323 and Media Gateway Control Protocol
  - ILMI
  - Multiple PVC Support
  - OAM
  - PPPoE Client
  - PPPoE over ATM
  - RFC 1483 Bridging
  - RFC 1483 Routing
  - Session Initiation Protocol
  - Survivable Remote Site Telephony (SRST)
  - VoATM over AAL2 (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)

- VoATM over AAL5 (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)
- VoIP over AAL5

Table 1 lists the voice and QoS features for ADSL and G.SHDSL and the releases in which they are available. Table 2 provides some summary information regarding platform support for each release. Refer to Cisco IOS release notes at cisco.com for more details about platform support and memory requirements for each release.

Note Features marked with a pound symbol (#) are not available on the Cisco 1700 series.

Table 1 Voice and QoS Features and the Releases in Which They Are Available

Feature	Releases
Access Control Lists	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Analog Voice Interface Support	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
ATM CLP Bit Marking	12.2(8)YN
ATM Traffic Shaping	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Class-Based Packet Marking with Differentiated Services	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Class-Based Policing	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Class-Based Weighted Fair Queueing (CBWFQ)	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Class-Based WRED with DSCP (egress)	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Clock Rate for AAL5 and AAL2	12.2(8)YN
Committed Access Rate (CAR)	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, and 12.2(13)T
Concurrent VoIP and VoATM #	12.2(2)XK, 12.2(4)XL, and 12.2(8)YN
cRTP over an ATM Link with PPP Encapsulation	12.2(8)YN
Dial-Peer DSCP and IP Precedence Marking	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
F5 OAM CC Segment Functionality	12.2(4)XL, 12.2(8)YN, and 12.2(13)T
FRF.5 and FRF.8	12.2(8)YN
H.323 and Media Gateway Control Protocol (MGCP) Testing	12.2(8)YN
ILMI	12.2(4)XL, 12.2(8)YN, and 12.2(13)T
IP QoS Map to ATM Class of Service (CoS)	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Link Fragmentation and Interleaving (LFI)	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T

Table 1 Voice and QoS Features and the Releases in Which They Are Available (continued)

Feature	Releases
Local Policy Routing	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Low Latency Queueing	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
MLP Bundling	12.2(8)YN
Multiple PVC Support	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Network-Based Application Recognition (NBAR)	12.2(8)YN
OAM	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Per-VC Queueing	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Policy-Based Routing	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
PPPoE Client	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
PPPoE MTU Adjustment	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
PPPoE over ATM	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
RFC 1483 Bridging	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
RFC 1483 Routing	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Resource Reservation Protocol (RSVP)	12.2(8)YN
Session Initiation Protocol (SIP)	12.2(8)YN
Survivable Remote Site Telephony (SRST)	12.2(8)YN
Traffic Policing	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Tunable Transmission Ring	12.2(8)YN
VC Bundling	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
VC Shaping for Variable Bit Rate-Nonreal Time (VBR-NRT)	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
VoATM over AAL2 #	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
VoATM over AAL5 #	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T

Table 1 Voice and QoS Features and the Releases in Which They Are Available (continued)

Feature	Releases
VoIP over AAL5	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Weighted Random Early Detection (WRED)	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T

Table 2 lists the Cisco IOS releases in which voice and QoS Support for ADSL and G.SHDSL are available and the platforms supported on each release. A "yes" means that the Cisco platform listed in the header row is supported on the release listed in the "Release" column. An "x" means that the Cisco platform is not supported in the release listed in the "Release" column.

Table 2 Cisco IOS Releases on Which ADSL and G.SHDSL Voice and QoS Support Are Available and the Platforms Supported on Each Release

Release	1720	1721	175x	1760	2610-2651	2610XM-2651XM	2691	3620	3640	3640A	3660	3700
12.2(2)XQ	Yes	x	Yes	x	x	x	x	x	x	x	x	x
12.2(2)XK	Yes	x	Yes	Yes	Yes	x	x	Yes	Yes	x	Yes	x
12.2(4)XL	Yes	x	Yes	Yes	Yes	x	x	Yes	Yes	x	Yes	x
12.2(8)YN	Yes	Yes	Yes	Yes	x	Yes	x	x	Yes	Yes	Yes	x
12.2(13)T	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Classification and Marking

The following Cisco IOS classification and marking features are supported on ADSL WICs and G.SHDSL WICs:

- ATM CLP Bit Marking
- Class-Based Packet Marking with Differentiated Services
- Committed Access Rate
- Dial-Peer DSCP and IP Precedence Marking
- Local Policy Routing
- Network-Based Application Recognition
- Policy-Based Routing

ATM CLP Bit Marking

When congestion occurs in an ATM network, ATM cells are discarded. One way to control which cells are discarded is to use the cell loss priority (CLP) bit in the ATM header of each cell. The CLP bit may be set to either 1 or 0. Those cells that have the CLP bit set to 1 are always discarded before any of the cells that have the CLP bit set to 0.

The ATM CLP Bit Marking feature allows you to control the CLP setting on Cisco routers. The marking of the CLP bit is implemented on a per-packet basis so that the CLP bit of every ATM cell that belongs to a particular packet is set to either 0 or 1.

For an example of output in which ATM CLP Bit Marking has been enabled, see the section "ATM CLP Bit Marking over G.SHDSL Example."

For more information about ATM cell bit marking, refer to the following document:

- *When Does a Router Set the CLP Bit in an ATM Cell?*

Class-Based Packet Marking with Differentiated Services

For information about class-based packet marking with differentiated services, refer to the following document:

- The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Committed Access Rate

For information about committed access rate (CAR), refer to the following document:

- The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Dial-Peer DSCP and IP Precedence Marking

For information about dial-peer differentiated services code points (DSCPs) and IP precedence marking, refer to the following document:

- The document "Quality of Service for Voice over IP"

Local Policy Routing

For information about local policy routing (LPR), refer to the following documents:

- The chapter "Configuring IP Routing Protocol—Independent Features" in the *Cisco IOS IP Configuration Guide*, Release 12.2
- The chapter "Configuring IP Routing Protocols" in the *Router Products Configuration Guide*

Network-Based Application Recognition

For information about network-based application recognition (NBAR), refer to the following documents:

- *Network-Based Application Recognition*, Release 12.1
- *Using Content Networking to Provide Quality of Service*
- The chapter "Configuring Network-Based Application Recognition" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Policy-Based Routing

For information about policy-based routing (PBR), refer to the following documents:

- The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- The chapter "Configuring Policy-Based Routing" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Queueing and Scheduling

The following Cisco IOS queueing and scheduling features are supported on ADSL WICs and G.SHDSL WICs:

- Class-Based Weighted Fair Queueing
- Low Latency Queueing
- Per-VC Queueing

Class-Based Weighted Fair Queueing

For information about class-based weighted fair queueing (CBWFQ), refer to the following document:

- The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Low Latency Queueing

For information about low latency queueing (LLQ), refer to the following documents:

- The chapter "Congestion Management Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- The chapter "Quality of Service for Voice over IP" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Note Low latency queueing works in conjunction with setting the transmission (tx) ring. (For more information about setting the tx ring, see the "Tunable Transmission Ring" section on page 12.)

Per-VC Queueing

Per-virtual circuit (per-VC) queueing is supported on ADSL and G.SHDSL interfaces at the driver level, similar to VC-queueing features on other ATM interfaces. This feature underlies many of the Cisco IOS QoS queueing features, such as LLQ.

For more information about per-VC queueing, refer to the following documents:

- *Understanding Weighted Fair Queuing on ATM*
- *Per-VC Class-Based, Weighted Fair Queuing (Per-VC CBWFQ) on the Cisco 7200, 3600, and 2600 Routers*

Congestion Avoidance

The following Cisco IOS congestion avoidance features are supported on ADSL WICs and G.SHDSL WICs:

- Class-Based Weighted Random Early Detection with DSCP (egress)
- Resource Reservation Protocol
- Weighted Random Early Detection

Class-Based Weighted Random Early Detection with DSCP (egress)

Class-Based Weighted Random Early Detection (WRED) is supported on ADSL and G.SHDSL WICs.

For more information about WRED, refer to the following documents:

- The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2
- *DiffServ Compliant Weighted Random Early Detection*

Resource Reservation Protocol

For information about Resource Reservation Protocol (RSVP), refer to the following documents:

- The chapter "Configuring RSVP" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- The chapter "Configuring RSVP Support for LLQ" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- The chapter "Configuring RSVP Support for Frame Relay" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- The chapter "Configuring RSVP-ATM QoS Interworking" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Weighted Random Early Detection

For information about Weighted Random Early Detection (WRED), refer to the following document:

- The chapter "Configuring Weighted Random Early Detection" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Policing and Traffic Shaping

The following Cisco IOS policing and shaping features are supported on ADSL WICs and G.SHDSL WICs:

- ATM Traffic Shaping
- Class-Based Policing
- Traffic Policing
- VC Shaping for Variable Bit Rate-Nonreal Time

ATM Traffic Shaping

For information about ATM traffic shaping, refer to the following document:

- *Configuring Traffic Shaping on Frame Relay to ATM Service Interworking (FRF.8) PVCs*
- The chapter "Policing and Shaping Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Class-Based Policing

For information about traffic classes and traffic policies, refer to the following document:

- The chapter "Configuring Traffic Policing" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Traffic Policing

For information about traffic policing, refer to the following documents:

- The chapter "Configuring Traffic Policing" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Comparing Class-Based Policing and Committed Access Rate*

VC Shaping for Variable Bit Rate-Nonreal Time

For information about VC shaping for variable bit rate-nonreal time (VBR-NRT), refer to the following document:

- *Understanding the VBR-nrt Service Category and Traffic Shaping for ATM VCs*

Link Efficiency

The following link latency features are supported on ADSL WICs and G.SHDSL WICs:

- cRTP over an ATM Link with PPP Encapsulation
- Link Fragmentation and Interleaving
- MLP Bundling
- PPPoE MTU Adjustment
- Tunable Transmission Ring
- VC Bundling

cRTP over an ATM Link with PPP Encapsulation

The Compressed Real-Time Protocol (cRTP) feature reduces bandwidth consumption on real-time applications such as voice. Thus, by using cRTP, you can further improve voice quality. Configuring cRTP can save troubleshooting time by isolating potential cRTP issues. Based on RFC 2508, the RTP header compression feature compresses the IP, User Data Protocol (UDP), and Real-Time Transport

Protocol (RTP) header (IP/UDP/RTP header) from 40 bytes to 2 or 4 bytes, reducing unnecessary bandwidth consumption. It is a hop-by-hop compression scheme; therefore, cRTP must be configured on both ends of the link (unless the passive option is configured).

To configure cRTP, use the **ip rtp header-compression** command.

Because the compression process can be CPU intensive, RTP header compression was implemented in the fast-switching and Cisco Express Forwarding (CEF) switching paths in Cisco IOS Release 12.0.(7)T. Sometimes the cRTP implementations are broken, and if they are broken, the only way that cRTP will work is to use process switching. It is recommended that cRTP be used with links lower than 768 kbps unless the router is running at a low CPU utilization rate. Monitor the CPU utilization of the router, and disable cRTP if it is above 75 percent.

When you configure the **ip rtp header-compression** command, the router adds the **ip tcp header-compression** command to the configuration by default. This command is used to compress the TCP/IP packets of the headers. Header compression is particularly useful on networks that have a large percentage of small packets, such as those supporting many Telnet connections. The TCP header compression technique, described fully in RFC 1144, is supported on serial lines using High-Level Data Link Control (HDLC) or PPP encapsulation.

To compress the TCP headers without enabling cRTP, use the **ip tcp header-compression** command.

To enable cRTP over an ATM Link with PPP Encapsulation, see the "Configuring cRTP over an ATM Link with ATM Encapsulation" table.

Link Fragmentation and Interleaving

For information about the Link Fragmentation and Interleaving (LFI) feature, refer to the following document:

- The chapter "Configuring Link Fragmentation and Interleaving for Frame Relay and ATM Virtual Circuits" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

MLP Bundling

Multilink PPP (MLP), standardized in RFC 1990, is similar to load balancing techniques in that it sends packets across the individual links in a round-robin fashion. However, MLP adds three significant capabilities:

- Because MLP works at the link layer, it makes an MLP bundle appear as one logical link to the upper layer protocols in the router. Thus, only one network address needs to be configured for the entire MLP bundle.
- MLP keeps track of packet sequencing and buffers packets that arrive early. With this ability, MLP preserves packet order across the entire MLP bundle.
- Packet fragmentation can be enabled to split large data packets into smaller packet fragments that are individually transmitted across the links. In many circumstances, fragmentation can increase the efficiency of the MLP link.

Additionally, when more bandwidth is needed, additional links can be added to the bundle by simply configuring them as members of the bundle. No reconfiguration at the network layer, such as new addressing, is needed. This is also a significant factor when considering the use of advanced router services. For example, a specific QoS can be configured once for the bundle as a whole rather than on each link in the bundle.

The trade-off for the increased functionality is that MLP requires greater CPU processing than load-balancing solutions. Packet reordering, fragment reassembly, and the MLP protocol itself increase the CPU load.

Note

- The fragment delay on the multilink interface should be configured on the basis of the desired maximum delay for interleaved packets. Interleaving is useful only at low bandwidths, usually below 1 Mbps, and it is dependent on the link bandwidths, not the bundle bandwidth.
- It is recommended that IP CEF be turned on. IP CEF will result in better performance and ease of configuration.
- Virtual template (VT) should be used (instead of dialer interface) when configuring either authentication or dynamic address assignment for MLP with LFI.

To enable MLP bundling, see the section "Configuring MLP Bundling."

PPPoE MTU Adjustment

If a Cisco router terminates the PPP over Ethernet (PPPoE) traffic, a computer connected to the Ethernet interface may have a problem accessing websites. The solution is to manually reduce the maximum transmission unit (MTU) configured on the computer by constraining the TCP maximum segment size (MSS). To manually reduce the MTU configured on the computer, use the **ip tcp adjust-mss** command. The *mss* argument value must be 1452 or less.

For more information about adjusting the PPPoE MTU, refer to the following document:

- *Software Enhancements for the Cisco 800 Routers and SOHO Routers*

Tunable Transmission Ring

The transmission (tx) ring is the FIFO buffer used to hold frames before transmission at the DSL driver level. The tx ring defines the maximum number of packets that can wait for transmission at Layer 2.

The tx ring complements the ability of LLQ to minimize jitter and latency of voice packets. For maximum voice quality, a low tx ring setting should be used. For maximum data throughput, a high tx ring setting should be used.

You can configure the size of the tx ring for each permanent virtual circuit (PVC). The default value is 60. However, the value of the setting can be 2 through 60 on Cisco 1700 series routers and 3 through 60 on Cisco 2600 and Cisco 3600 series routers. A low tx ring setting, such as 2 or 3, is required for latency-critical traffic. For example, when the tx ring limit is configured as 3 and LLQ is configured on the PVC, the worst case delay for a voice packet is the time required to transmit three data packets. When the buffering is reduced by configuring the tx ring limit, the delay experienced by voice packets is reduced by a combination of the tx ring and LLQ mechanism.

Note The size of the tx ring buffer is measured in packets, not particles.

VC Bundling

For infomation about virtual circuit (VC) bundling, refer to the following document:

- *Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers*

Other (IP QoS)

The following IP QoS features are supported on ADSL WICs and G.SHDSL WICs:

- Access Control Lists
- IP QoS Map to ATM Class of Service

Access Control Lists

For infomation about access control lists, refer to the following document:

- The chapter "Configuring IP Services" in the *Cisco IOS IP Configuration Guide*, Release 12.2

IP QoS Map to ATM Class of Service

For information about IP QoS map to ATM class of service (CoS), refer to the following document:

- The chapter "Configuring IP to ATM Class of Service" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Additional Supported Features

The following Cisco IOS features are supported on ADSL WICs and G.SHDSL WICs:

- Analog Voice Interface Support (requires an appropriate VIC)
- Clock Rate for AAL5 and AAL2
- Concurrent VoIP and VoATM (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)
- F5 OAM CC Segment Functionality
- FRF.5 and FRF.8
- H.323 and Media Gateway Control Protocol
- ILMI
- Multiple PVC Support
- OAM
- PPPoE Client
- PPPoE over ATM
- RFC 1483 Bridging
- RFC 1483 Routing
- Session Initiation Protocol
- Survivable Remote Site Telephony
- VoATM over AAL2 (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)
- VoATM over AAL5 (supported only on the Cisco 2600, Cisco 3600, and Cisco 3700 series)
- VoIP over AAL5

Analog Voice Interface Support

Note The Analog Voice Interface Support feature requires an appropriate VIC.

For more information about analog voice interface support, refer to the following document:

- *Voice Port Testing Enhancements in Cisco 2600 and 3600 Series Routers and MC3810 Series Concentrators*

Clock Rate for AAL5 and AAL2

The communication between DSL WICs and a host in a router occurs through a device called the Serial Communication Controller (SCC). If a host wants to forward data or send any control traffic to a DSL WIC, it uses SCCs. In the same way, if a DSL WIC wants to forward incoming data from a line to the host, it also uses SCCs. Each DSL WIC installed in the router uses two SCCs. One SCC (SCC-A) is used for AAL5 data traffic, and the other SCC (SCC-B) is used for AAL2 and control traffic. The speed at which the SCC transfers data between a host and a WIC depends on the clock rate with which it has been configured. You can configure this clock rate on the basis of the DSL line rate. Even though the DSL upstream and downstream line rate may vary, the clock rate between the SCC and the DSL WIC is the same for both the transmitting and receiving direction. That is, the communication between the SCC and the DSL WIC is synchronous. Therefore, you need to configure only one clock rate for an SCC that will be used for both transmitting and receiving between an SCC and a DSL WIC.

It is always recommended that you configure the SCC clock rate slightly higher than the DSL line rate to accommodate overhead between the SCC and the DSL WIC. For an asynchronous DSL WIC (for example, ADSL), the SCC clock rate depends on either the downstream or the upstream line rate, whichever is the maximum rate. For a synchronous DSL WIC (for example, G.SHDSL), the bandwidth for upstream and downstream is the same. Therefore, the SCC clock rate configuration can be based on either the upstream or the downstream line rate.

To configure the clock, use the **clock rate** command, which is shown in the section "Configuring the Clock Rate for ADSL and G.SHDSL WICs."

Maximum Clock Rate Limits and Defaults

Because the maximum line rate for G.SHDSL is 2.312 Mbps, the default SCC clock rate of 2.6 Mbps for AAL5 and 1 Mbps for AAL2 should be sufficient. However, for ADSL, the clock rate may need to be configured on the basis of the current line rate. If AAL2 is used for voice traffic, the AAL2 SCC must be configured to the appropriate clock rate: 1 Mbps for ADSL and 2.6 Mbps for G.SHDSL.

The maximum data rate between an SCC and a DSL WIC depends primarily on the maximum clock rate that the SCC can support. For example, on the Cisco 2600 series mainboard, which supports two DSL WICs, the total SCC clock rate that can be configured for both WICs is 8 Mbps. Therefore, if only one DSL WIC is present on the mainboard, AAL5 and AAL2 clock rates can be configured to 7 Mbps and 1 Mbps, respectively. If two DSL WICs are supported on the mainboard, the total of 8 Mbps should be distributed among the four SCCs.

Network module SCCs also pose similar limitations. That is, on the Cisco 2600 series, the total clock rate for all four SCCs is 8 Mbps. The maximum AAL5 clock rate that may be configured on a network module is 5.3 Mbps. On the Cisco 1700 series, the maximum configurable SCC clock rate for both AAL5 and AAL2 is 8 Mbps.

If the clock rate is unconfigured, the SCC is reset to the default values. See the **clock rate (interface ATM)** command for a more complete explanation of default values and maximum and minimum values.

Concurrent VoIP and VoATM

The Concurrent VoIP and VoATM feature allows you to make VoIP over ATM (aal5snap) and VoATM (aal5mux) calls concurrently over xDSL.

Note This feature is not supported on the Cisco 1700 series.

F5 OAM CC Segment Functionality

For information about F5 Operation, Administration, and Maintenance Continuity Check (F5 OAM CC) segment functionality, refer to the following documents:

- "Cisco Product Bulletin No. 1518" about Cisco IOS software Release 12.2(2)XJ
- *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(2)XJ*

FRF.5 and FRF.8

To communicate over WANs, end-user stations and the network cloud typically must use the same type of transmission protocol. This limitation has prevented differing networks such as Frame Relay and ATM from being linked. The Frame Relay-to-ATM service interworking feature allows Frame Relay and ATM networks to exchange data despite differing network protocols. The functional requirements for linking Frame Relay and ATM networks are provided by the *Frame Relay/ATM PVC Service Interworking Implementation Agreement* specified in Frame Relay Forum (FRF) documents FRF.5 and FRF.8. The FRF.5 and FRF.8 interworking functions involve multiplexing PVCs between Frame Relay and ATM networks and mapping the control bits between Frame Relay frame headers and ATM cell headers. FRF.5 and FRF.8 are necessary for ATM-based features to interwork with Frame-Relay-based IP class of service features.

To configure FRF.5 and FRF.8, see the sections "Configuring FRF.5" and "Configuring FRF.8."

H.323 and Media Gateway Control Protocol

For information about H.323 and Media Gateway Control Protocol (MGCP) testing, refer to the following document:

- The chapter "*H.323 Applications*" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2

ILMI

For information about Integrated Local Management Interface (ILMI) protocol implementation for Cisco digital subscriber loop access multiplexers (DSLAMs) with N1-2 cards, refer to the following document:

- The chapter "Configuring ILMI" in the *Configuration Guide for Cisco DSLAMS with N1-2*

Multiple PVC Support

Note The maximum number of PVCs that can be supported is 23.

For information about PVCs, refer to the following documents:

- The chapter "Wide-Area Networking Overview" in *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2
- The chapter "Configuring ATM" in the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2

Refer to the following documents for caveat information for multiple PVCs on Cisco 1700 series, Cisco 2600 series, and Cisco 3600 series routers for Cisco IOS Release 12.2(2)XK:

- *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(2)XK*
- *Release Notes for Cisco 2600 Series for Cisco IOS Release 12.2 XK*
- *Release Notes for Cisco 3600 Series for Cisco IOS Release 12.2 XK*

Refer to the following documents for caveat information for multiple PVCs on Cisco 1700 series, Cisco 2600 series, and Cisco 3600 series routers for Cisco IOS Release 12.2(4)XL:

- *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(4)XL*
- *Release Notes for Cisco 2600 Series for Cisco IOS Release 12.2 XL*
- *Release Notes for Cisco 3600 Series for Cisco IOS Release 12.2 XL*

Refer to the following document for caveat information for multiple PVCs on Cisco 1700 series routers for Cisco IOS Release 12.2(8)YN:

- *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(8)YN*

OAM

For infomation about Operation, Administration, and Maintenance (OAM), refer to the following document:

- *Configuring Operation, Administration, and Maintenance*, Release 12.1

PPPoE Client

For information about the Point-to-Point Protocol over Ethernet (PPPoE) Client feature, refer to the following document:

- PPP over Ethernet Client

PPPoE over ATM

PPPoE over ATM enables PPP sessions to be transported via an Ethernet-connected PC over an ATM DSL link. For more information about the PPPoE over ATM feature, refer to the following document:

- *PPPoE on ATM*

RFC 1483 Bridging

For information about RFC 1483 bridging, refer to the following documents:

- *Basic PVC Configuration Using Bridged RFC 1483*
- *DSL Network Architectures*

RFC 1483 Routing

For information about ATM and ATM adaptation layers (AALs), refer to the following document:

- The chapter "Wide-Area Networking Overview" in the *Cisco IOS Wide-Area Networking Configuration Guide,* Release 12.2

Session Initiation Protocol

For information about Session Initiation Protocol (SIP), refer to the following document:

- The chapter "Configuring Session Initiation Protocol for Voice over IP" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2

Survivable Remote Site Telephony

For information about Survivable Remote Site Telephony (SRST), refer to the following document:

- The solutions document *Survivable Remote Site Telephony Cisco 2600/3600 Voice Technical Marketing*

VoATM over AAL2

For information about Voice over ATM over AAL2, refer to the following documents:

- The chapter "Configuring Voice over ATM" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2.
- *Configuring AAL2 and AAL5 for the High-Performance ATM Advanced Integration Module on the Cisco 2600 Series*

Note The Voice over ATM over AAL2 feature is not supported on the Cisco 1700 series.

VoATM over AAL5

For information about Voice over ATM over AAL5, refer to the following document:

- The chapter "Configuring Voice over ATM" in *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2

Note This feature is not supported on the Cisco 1700 series.

VoIP over AAL5

For information about Voice over IP over AAL5, refer to the following document:

- The chapter "*Configuring Voice over IP*" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2

Benefits

QoS provides improved and more predictable network service for ADSL and G.SHDSL by

- Supporting dedicated bandwidth.
- Improving loss characteristics.
- Avoiding and managing network congestion.
- Shaping network traffic.
- Setting traffic priorities across the network.
- Decreasing delay for voice and real-time traffic.

Restrictions

- Analog and BRI voice on the NM-1V/2V cards are not supported over VoATM in AAL2.
- F5 OAM CC segment functionality is not currently supported on Cisco DSLAMs.

Related Documents

See Table 3 for documents related to the Enhanced Voice and Qos for ADSL and G.SHDSL features on Cisco 1700 series, Cisco 2600 series, and Cisco 3600 series routers.

Table 3 Related Documents

Related Topic	Document Titles
AAL2	• The chapter "Configuring Voice over ATM" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2 • *Configuring AAL2 and AAL5 for the High-Performance ATM Advanced Integration Module on the Cisco 2600 Series*
Access control lists	• The chapter "Configuring IP Services" in the *Cisco IOS IP Configuration Guide*, Release 12.2

Table 3 Related Documents (continued)

Related Topic	Document Titles
ADSL and G.SHDSL WAN interface cards	• *Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers* • *Installing the G.SHDSL WIC on the Cisco 1700 Series Router* • *1-Port ADSL WAN Interface Card for Cisco 2600 Series and 3600 Series Routers*, Release 12.2(4)T • *1-Port G.SHDSL WAN Interface Card for Cisco 2600 Series and 3600 Series Routers*, Release 12.2(4)XL • *ADSL WAN Interface Card for the Cisco 2600/3600/3700 Series* • *G.SHDSL WAN Interface Card for the Cisco 2600/3600/3700 Series*
Analog voice interface support	• *Voice Port Testing Enhancements in Cisco 2600 and 3600 Series Routers and MC3810 Series Concentrators*
ATM CLP bit marking	• *When Does a Router Set the CLP Bit in an ATM Cell?*
ATM, configuring	• *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2 • *Cisco IOS Wide-Area Networking Command Reference*, Release 12.2
ATM traffic shaping	• *Configuring Traffic Shaping on Frame Relay to ATM Service Interworking (FRF.8) PVCs* • The chapter "Policing and Shaping Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Class-based packet marking with DSCP	• The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Class-based policing	• The chapter "Configuring Traffic Policing" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Class-based weighted fair queueing	• The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2

Table 3 Related Documents (continued)

Related Topic	Document Titles
Class-based WRED with DSCP (egress)	• The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2 • *DiffServ Compliant Weighted Random Error Detection*
Committed access rate (CAR)	• The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Dial-peer DSCPs and IP precedence marking	• The chapter "Quality of Service for Voice over IP" in *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
F5 OAM CC segment functionality	• "*Cisco Product Bulletin No. 1518*" about Cisco IOS software Release 12.2(2)XJ • *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(XJ)*
H.323 and Media Gateway Control Protocol (MGCP)	• The chapter "*H.323 Applications*" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*
ILMI	• The chapter "Configuring ILMI" in the *Configuration Guide for Cisco DSLAMS with N1-2*
IP, configuring	• *Cisco IOS IP Configuration Guide*, Release 12.2 • *Cisco IOS IP Command Reference*, Release 12.2 (there are three volumes)
IP QoS map to ATM CoS	• The chapter "Configuring IP to ATM Class of Service" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Link fragmentation and interleaving (LFI)	• The chapter "Configuring Link Fragmentation and Interleaving for Frame Relay and ATM Virtual Circuits" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Local policy routing (LPR)	• The chapter "Configuring IP Routing Protocols" in *Router Products Configuration Guide*

Table 3 Related Documents (continued)

Related Topic	Document Titles
Low latency queueing	• The chapter "Congestion Management Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • The chapter "Quality of Service for Voice over IP" in the *Cisco IOS Quality of Service Solutions*
MLP with LFI	• The chapter "Configuring Link Fragmentation and Interleaving for Multilink PPP" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
Multiple PVC support	• The chapter "Wide-Area Networking Overview" in the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2 • The chapter "Configuring ATM" in the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2
Network-based application recognition (NBAR)	• *Network-Based Application Recognition*, Release 12.1 • *Using Content Networking to Provide Quality of Service* • The chapter "Configuring Network-Based Application Recognition" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2.
OAM	• *Configuring Operation, Administration, and Maintenance, Release 12.1*
Per-VC queueing	• *Understanding Weighted Fair Queuing on ATM* • *Per-VC Class-Based, Weighted Fair Queuing (Per-VC CBWFQ) on the Cisco 7200, 3600, and 2600 Routers*
PPPoE client	• *PPP over Ethernet Client*
PPPoE MTU adjustment (**ip tcp adjust-mss** command)	• *Software Enhancements for the Cisco 800 Routers and SOHO Routers* • *Cisco 827 – Acting as a PPPoE Client with a Dynamic IP Address*
PPPoE over ATM	• *PPPoE on ATM*

Table 3 Related Documents (continued)

Related Topic	Document Titles
Policy-based routing	• The chapter "Quality of Service Overview" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • The chapter "Configuring Policy-Based Routing" in *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
QoS, configuring	• *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2
QoS features on Cisco 1700 series routers	• *Cisco IOS Software Release 12.2(2)XQ1*
Resource Reservation Protocol (RSVP)	• The chapter "Configuring RSVP" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • The chapter "Configuring RSVP Support for LLQ" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • The chapter "Configuring RSVP Support for Frame Relay" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • The chapter "Configuring RSVP-ATM QoS Interworking" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
RFC 1483 bridging	• *Basic PVC Configuration Using Bridged RFC 1483* • *DSL Network Architectures*
RFC 1483 Routing	For information about ATM and ATM adaptation layers: • The chapter "Wide-Area Networking Overview" in *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2 For information about AAL5 Subnetwork Access Protocol (AAL5SNAP) encapsulations: • The chapter "Configuring ATM" in the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2
Session Initiation Protocol (SIP)	• The chapter "*Configuring Session Initiation Protocol for Voice over IP*" in the *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2

Table 3 Related Documents (continued)

Related Topic	Document Titles
Survivable Remote Site Telephony (SRST)	• The solutions document *Survivable Remote Site Telephony Cisco 2600/3600 Voice Technical Marketing*
Traffic policer	• The chapter "Configuring Traffic Policing" in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 • *Comparing Class-Based Policing and Committed Access Rate*
VC bundling	• *Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers*
VC shaping for VBR-NRT	• *Understanding the VBR-nrt Service Category and Traffic Shaping for ATM VCs*
Voice configuration	• *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2 • *Cisco IOS Voice, Video, and Fax Command Reference*, Release 12.2
Voice over AAL5	• The chapter "Configuring Voice over ATM" in *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2
VoATM	• The chapter "Configuring Voice over ATM" in *Cisco IOS Voice, Video, and Fax Configuration Guide*, Release 12.2
WRED	• *DiffServ Compliant Weighted Random Error Detection*

Supported Platforms

- Cisco 1720
- Cisco 1721
- Cisco 1751
- Cisco 1751V
- Cisco 1760
- Cisco 1760V
- Cisco 2610-2651
- Cisco 2610XM
- Cisco 2611XM
- Cisco 2620XM
- Cisco 2621XM
- Cisco 2650 (not supported in Cisco IOS Release 12.2(8)YN)
- Cisco 2650XM

- Cisco 2651 (not supported in Cisco IOS Release 12.2(8)YN)
- Cisco 2651XM
- Cisco 2691
- Cisco 3620
- Cisco 3640
- Cisco 3640A
- Cisco 3660
- Cisco 3700 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that are supported on 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 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 found at this URL:

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

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by these features.

MIBs

The following MIBs are supported:

- ATM-MIB

- CISCO-AAL5-MIB
- CISCO-ATM-EXT-MIB
- CISCO-CAR-MIB
- CISCO-CLASS-BASED-QOS-MIB
- CISCO-IETF-ATM2-PVCTRAP-MIB
- Entity-MIB
- IF-MIB
- Old-Cisco-Chassis MIB
- RFC 1213 MIB

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

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

To access Cisco MIB Locator, 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 found at this URL:

http://www.cisco.com/register

RFCs

No new or modified RFCs are supported by these features.

Prerequisites

To configure the voice and QoS features, you must first install and configure the ADSL WIC or G.SHDSL WIC on your Cisco 1700 series, Cisco 2600 series, and Cisco 3600 series. For information about installing and configuring the ADSL and G.SHDSL WICs, see the “ADSL and G.SHDSL WAN interface cards” topic in the Related Documents section.

Configuration Tasks

See the following sections to configure the Enhanced Voice and QoS features for ADSL and G.SHDSL on Cisco routers. Each task in the list is identified as either required or optional.

- Configuring ATM CLP Bit Marking (optional)
- Verifying ATM CLP Bit Marking (optional)
- Configuring the Clock Rate for ADSL and G.SHDSL WICs (optional)
- Verifying the Clock Setting for ADSL and G.SHDSL WICs (optional)
- Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco Series (optional)
- Configuring cRTP over an ATM Link with ATM Encapsulation (optional)
- Verifying cRTP Statistics (optional)
- Configuring FRF.5 (optional)
- Verifying FRF.5 (optional)
- Configuring FRF.8 (optional)
- Verifying FRF.8 (optional)
- Configuring MLP Bundling (optional)
- Verifying MLP Bundling (optional)
- Configuring the Tx Ring Limit (optional)
- Verifying the Tx Ring Limit (optional)

Configuring ATM CLP Bit Marking

To configure ATM CLP bit marking, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# ip cef`	Enables Cisco Express Forwarding (CEF).
Step 2	`Router (config)# class-map` *class-map-name*	Creates a class map to be used for matching packets to a specified class and enters class map configuration mode. The *class-map-name* argument is the name of the class for the class map. The class name is used for both the class map and to configure policy for the class in the policy map.
Step 3	`Router (config-cmap)# match access-group` *access-group*	Specifies the numbered access list against whose contents packets are checked to determine whether they belong to the class. Refer to the *Cisco IOS Quality of Service Solutions Configuration Guide* for other **match** options.
Step 4	`Router (config-cmap)# exit`	Exits class map configuration mode.
Step 5	`Router (config)# policy-map` *policy-map-name*	Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy and enters policy map configuration mode. The *policy-map-name* argument is the name of the policy map.
Step 6	`Router (config-pmap)# class` *name*	Specifies the name of a traffic class to classify traffic for the policy traffic and enters policy-map class configuration mode. The *name* argument should be the same as the class-map name in Step 2 of this configuration.

	Command	Purpose
Step 7	`Router (config-pmap-c)# set atm-clp`	Controls the cell loss priority (CLP) bit setting on Cisco routers when a policy map is configured (changes the setting for all packets that match the specified class from 0 to 1).
Step 8	`Router (config-pmap-c)# exit`	Exits policy-map class configuration mode.
Step 9	`Router (config-pmap)# exit`	Exits policy-map configuration mode.
Step 10	`Router (config)# interface` *type slot/port.subinterface-number* [**multipoint** | **point-to-point**]	Configures an interface type and enters subinterface configuration mode. The arguments and keywords are as follows: • *type*—To configure ATM CLP bit marking, use atm for the *type* argument. • *slot*—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • *port*—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • *subinterface-number*—Subinterface number in the range 1 to 4294967293. The number that precedes the period (.) must match the number to which this subinterface belongs. • **multipoint**—(Optional) Multipoint subinterface. • **point-to-point**—(Optional) Point-to-point subinterface.
Step 11	`Router (config-subif)# pvc` *vpi/vci*	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC and enters ATM VC configuration mode. The arguments are as follows: • *vpi/*—ATM network virtual path identifier (VPI) for this PVC. The absence of the "/" and a VPI value defaults the VPI value to 0. • *vci*—ATM network virtual channel identifier (VCI) for this PVC. The VCI is a 16-bit field in the header of the ATM cell. The VCI value is unique only on a single link, not throughout the ATM network, because it has local significance only. **Note** The *vpi* and *vci* arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 12	`Router (config-if-atm-vc)# service-policy output` *policy-map-name*	Attaches a policy map to an interface to be used as the service policy for that interface. The arguments and keywords are as follows: • **output**—Attaches the specified policy map to the output interface. • *policy-map-name*—Name of a service policy map (created using the **policy-map** command) to be attached.

Verifying ATM CLP Bit Marking

The following **show atm pvc** command output from a Cisco 1721 router displays detailed information about the PVC. In this example, five packets are sent, with the CLP set to 1.

```
Router# show atm pvc 0/33

ATM0.1: VCD: 1, VPI: 0, VCI: 33
UBR, PeakRate: 2304
AAL5-LLC/SNAP, etype:0x0, Flags: 0x2000C20, VCmode: 0x0
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM END CC Activate retry count: 3, OAM END CC Deactivate retry count: 3
OAM END CC retry frequency: 30 second(s),
OAM SEGMENT CC Activate retry count: 3, OAM SEGMENT CC Deactivate retry count: 3
OAM SEGMENT CC retry frequency: 30 second(s),
OAM Loopback status: OAM Disabled
OAM VC state: Not Managed
ILMI VC state: Not Managed
InARP frequency: 15 minutes(s)
InPkts: 5, OutPkts: 5, InBytes: 560, OutBytes: 560
InPRoc: 5, OutPRoc: 5
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0/0/0 (holdq/outputq/total)
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0, LengthViolation: 0, CPIErrors: 0
Out CLP=1 Pkts: 5
OAM cells received: 0
F5 InEndloop: 0, F5 InSegloop: 0,
F5 InEndcc: 0, F5 InSegcc: 0, F5 InAIS: 0, F5 InRDI: 0
F4 InEndloop: 0, F4 InSegloop: 0, F4 InAIS: 0, F4 InRDI: 0
OAM cells sent: 0
F5 OutEndloop: 0, F5 OutSegloop: 0,
F5 OutEndcc: 0, F5 OutSegcc: 0, F5 OutRDI: 0
F4 OutEndloop: 0, F4 OutSegloop: 0, F4 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Configuring the Clock Rate for ADSL and G.SHDSL WICs

To configure the clock between a WIC and the hosts that are used by the WIC, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`(Router-config)# interface atm` *slot*`/`*port*	Configures an ATM interface type and enters interface configuration mode.

	Command	Purpose
Step 2	`Router (config-if)# clock rate [aal2 | aal5] clock-rate-value`	Configures the clock rate between a WIC and the SCCs that are used by the WIC. The keywords and arguments are as follows: • **aal2**—Clock rate for the AAL2 channel. • **aal5**—Clock rate for the AAL5 channel. • *clock-rate-value*—The clock rate can be set as follows: – **aal2**—For Cisco 1700 series routers, the minimum value for ADSL and G.SHDSL is 4 Mbps. The default value for ADSL and G.SHDSL is 8 Mbps. For Cisco 2600 and 3600 series routers, the minimum value for ADSL and G.SHDSL is 1 Mbps. The maximum value is 7 Mbps for mainboard slots and 5.3 Mbps for network modules. The default value for ADSL and G.SHDSL is 2.6 Mbps for both mainboard slots and network modules. To make full use of the 2.3 Mbps bandwidth for VoATM non-switched trunk calls on G.SHDSL, you can change the 1 Mbps default value on Cisco 2600 series and Cisco 3600 series routers and configure the AAL2 clock rate as 2.6 Mbps. It is recommended, however, that you keep the ADSL SCC clock rate for AAL2 at the default value of 1 Mbps because the upstream of ADSL cannot exceed 1 Mbps. **Note** Change the AAL2 default value on Cisco 2600 and Cisco 3600 series routers only if you are using G.SHDSL for VoATM non-switched trunk calls using a NM-HDV. All other times, the default for AAL2 should remain at 1 Mbps for ADSL and G.SHDSL. – **aal5**—For Cisco 1700 series routers, the minimum value for ADSL and G.SHDSL is 4 Mbps. The default value for ADSL and G.SHDSL is 8 Mbps. For Cisco 2600 and 3600 series routers, the minimum value for ADSL and G.SHDSL is 1 Mbps. The maximum value is 7 Mbps for mainboard slots and 5.3 Mbps for network modules. The default value for ADSL and G.SHDSL is 2.6 Mbps for both mainboard slots and network modules. **Note** If you configure a clock rate that exceeds the maximum limit, the configuration will fail. (See "Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco Series.")

	Command	Purpose

Step 3	`Router (config-if)# no clock rate aal5`
	or
	`Router (config-if)# no clock rate aal2`
		Disables the clock setting for AAL5 or AAL2, respectively, and changes the clock rate to the default setting.
		The other method for changing the AAL5 or AAL2 clock rate into the default rate is to configure the clock rate to the actual default settings.

Verifying the Clock Setting for ADSL and G.SHDSL WICs

To verify the clock rate setting for an ADSL WIC or G.SHDSL WIC on a Cisco 1700, Cisco 2600, or Cisco 3600 series router, use the **show running-config** or the **show controllers atm** command in EXEC mode.

Cisco 1700 Series Router

```
Router# show running-config interface atm0/0

interface ATM0/0
 ip address 1.0.0.1 255.255.255.0
 no ip route-cache
 load-interval 30
 clock rate aal2 4000000
 no atm ilmi-keepalive
 pvc 0/33
!
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
```

Cisco 1700 Series Router

```
Router# show controllers atm0/0

Interface: ATM0/0, Hardware: DSLSAR (with Globespan G.SHDSL module), State:
up
IDB:     82201E98  Instance: 8220364C  reg_dslsar:68030000  wic_regs:
68030080
PHY Inst:822251DC  Ser0Inst: 821FC328  Ser1Inst:  821FF41C  us_bwidth:192
Slot:    0         Unit:     0         Subunit:   0         pkt Size: 4528
VCperVP: 256       max_vp:   256       max_vc:    65536     total vc: 1
rct_size:65536     vpivcibit:16        connTblVCI:8         vpi_bits: 8
vpvc_sel:3         enabled:  0         throttled: 0         cell drops:
0
Parallel reads to TCQ:0  tx count reset = 0, periodic safe start = 0
Serial idb(AAL5) output_qcount:0 max:40
Serial idb(RAW) output_qcount:0, max:40
Sar ctrl queue: max depth = 9, current queue depth = 0, drops = 0, urun
cnt = 0,
total cnt = 153
Serial idb tx count: AAL5: 0, RAW: 0, Drop count:AAL5: 0, RAW: 0
SCC Clockrates:
    SCC-A = 8000000
    SCC-B = 4000000
```

In the above example, SCC-A represents the SCC clock rate for AAL5 and SCC-B represents the SCC clock rate for AAL2.

Cisco 2600 Series Chassis WIC Slots

The following **show controllers atm** example from a Cisco 2621 router shows verification of the SCC clock rates for ATM interface 0/0 on mainboard slot 0 and ATM interface 0/1 on mainboard slot 1:

```
Router# show controllers atm 0/0

Interface: ATM0/0, Hardware: DSLSAR (with Globespan G.SHDSL module), State: up
IDB:     8295D918  Instance: 8295F0CC  reg_dslsar:67000000  wic_regs: 67000080
PHY Inst:82981024  Ser0Inst: 8294C2B4  Ser1Inst:  82954DD8  us_bwidth:2304
Slot:    0         Unit:     0         Subunit:   0         pkt Size: 4528
VCperVP: 256       max_vp:   256       max_vc:    65536     total vc: 2
rct_size:65536     vpivcibit:16        connTblVCI:8         vpi_bits: 8
vpvc_sel:3         enabled:  0         throttled: 0         cell drops: 0
Parallel reads to TCQ:2  tx count reset = 0, periodic safe start = 0
Serial idb(AAL5) output_qcount:0 max:40
Serial idb(RAW) output_qcount:0, max:40
Sar ctrl queue: max depth = 10, current queue depth = 0, drops = 0, urun cnt = 0, total
cnt = 105
Serial idb tx count: AAL5: 90277249, RAW: 105, Drop count:AAL5: 0, RAW: 0
SCC Clockrates:
        SCC0 = 2600000 (ATM0/0)
        SCC1 = 2600000 (ATM0/1)
        SCC2 = 1000000 (ATM0/1)
        SCC3 = 1000000 (ATM0/0)
```

In the above example, the ADSL WIC in slot 0 uses SCC0 and SCC3. The AAL5 and AAL2 SCC clock rate of the WICs are 2 Mbps and 4 Mbps, respectively. The second WIC in slot 1 uses SCC1 and SCC2 for AAL5 and AAL2.

Cisco 2600 Series Network Router

The SCC assignment on a network module is different. The following **show controllers atm** example is from ATM interface 1/0, which is on network module slot 0. The example is from a Cisco 2650XM router.

```
Router# show controllers atm1/0

Interface: ATM0/0, Hardware: DSLSAR (with Globespan G.SHDSL module), State: up
IDB:     8295D918  Instance: 8295F0CC  reg_dslsar:67000000  wic_regs: 67000080
PHY Inst:82981024  Ser0Inst: 8294C2B4  Ser1Inst:  82954DD8  us_bwidth:2304
Slot:    0         Unit:     0         Subunit:   0         pkt Size: 4528
VCperVP: 256       max_vp:   256       max_vc:    65536     total vc: 2
rct_size:65536     vpivcibit:16        connTblVCI:8         vpi_bits: 8
vpvc_sel:3         enabled:  0         throttled: 0         cell drops: 0
Parallel reads to TCQ:2  tx count reset = 0, periodic safe start = 0
Serial idb(AAL5) output_qcount:0 max:40
Serial idb(RAW) output_qcount:0, max:40
Sar ctrl queue: max depth = 10, current queue depth = 0, drops = 0, urun cnt = 0, total
cnt = 105
Serial idb tx count: AAL5: 90277249, RAW: 105, Drop count:AAL5: 0, RAW: 0
SCC Clockrates:
        SCC0 = 2600000 (ATM0/0)
        SCC1 = 2600000 (ATM0/1)
        SCC2 = 1000000 (ATM0/1)
        SCC3 = 1000000 (ATM0/0)
```

Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco Series

The system limitation for Cisco 2600 and Cisco 3600 series routers is that the total SCC clock rate that can be configured for one or more WICs is 8 Mbps. The following troubleshooting tips for Cisco 2600 and Cisco 3600 routers explain situations for which warning and error messages can be received because of the 8 Mbps limitation.

Step 1 If you configure a clock rate that exceeds the maximum limit, the configuration will fail. In the following example (on a Cisco 2621 router), both the AAL5 SCC and the AAL2 SCC have been configured to 4 Mbps. Then an additional 7 Mbps are configured on the AAL5 SCC. The following error message indicates that the maximum clock rate configured on the AAL5 SCC is 4 Mbps, including the existing clock rate:

```
Router (config)# interface atm 0/0
Router (config-if)# clock rate aal5 7000000
%error: insuffcient clockrates, available (including current clock rate) = 4000000 bps
%Clockrate configuration failed
```

Step 2 If you have already configured your DSL WIC and then add a second WIC, you may exceed the maximum Mbps limit and receive a message such as the following, which shows that the failed DSL interface is shut down and that the clock rates are set to zero:

```
1d20h: %DSLSAR-1-NO_SCC_CLK_ERR: ATM1/0: Interface is DOWN because the sum of the clock
rate values for both the WICs in slots 0 and 1 exceeded maximum capacity. Please configure
clock rates using clock rate command in interface mode such that the sum of clock rate on
both the WICs does not exceed 8000000 bps. For a DSL wic, please include aal5 and aal2
clock rate values while calculating the total.
```

If you add a second WIC, make sure that you reduce the clock rate of the existing DSL so that the combined clock rates do not exceed the maximum.

Step 3 Non-DSL WICs, such as serial WICs, do not restrict you from configuring more than the maximum SCC clock rate. If these non-DSL WICs coexist with DSL WICs, the dynamic SCC clock rate configuration for the non-DSL WIC is monitored and checked for the maximum limit. If the total SCC clock rate exceeds the maximum limit, the %DSLSAR-1-NO_SCC_CLK_ERR message is displayed and DSL interfaces are shut down. In this case, the SCC clock rates of the shut-down DSL interface are not reset to zero. If you reconfigure the SCC clock rate so that the current clock rate is less than or equal to the maximum limit, the shut-down interface is automatically brought up and the error message will cease to display.

Configuring cRTP over an ATM Link with ATM Encapsulation

To configure cRTP over an ATM link with ATM encapsulation, 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 card.
Step 2	`Router (config)# class-map [match-all] class-map-name`	Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.
Step 3	`Router (config-cmap)# match access-group name access-group-number`	Configures the match criteria for a class map on the basis of the specified access control list (ACL).
Step 4	`Router (config-cmap)# class-map [match-all] class-map-name`	Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.
Step 5	`Router (config-cmap)# match access-group name access-group-number`	Configures the match criteria for a class map on the basis of the specified ACL.
Step 6	`Router (config-cmap)# policy-map policy-map-name`	Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy and enters policy-map configuration mode.
Step 7	`Router (config-pmap)# class class-name`	Specifies the name of the class whose policy you want to create or change or specifies the default class (commonly known as the class-default class) before you configure its policy.
Step 8	`Router (config-pmap)# priority {bandwidth-kbps | percent percentage}`	Gives priority to a class of traffic belonging to a policy map.
Step 9	`Router (config-pmap)# fair-queue [queue-limit queue-value]`	Specifies the number of queues to be reserved for use by a traffic class.
Step 10	`Router (config-pmap)# exit`	Exits policy-map configuration mode.
Step 11	`Router (config-cmap)# exit`	Exits class map configuration mode.
Step 12	`Router (config)# interface type interface-number`	Enters interface configuration mode. Use Loopback for the *type* argument. Use 1 for the *interface-number* argument. Loopback 1 is a standard configuration for Multilink PPP (MLP) over ATM.
Step 13	`Router (config-if)# ip address ip-address mask [secondary]`	Sets a primary or secondary IP address for an interface.
Step 14	`Router (config-if)# interface atm slot/port`	Configures an ATM interface type.
Step 15	`Router (config-if-atm)# no ip address`	Removes an IP address or disables IP processing.
Step 16	`Router (config-if-atm)# load-interval seconds`	Changes the length of time for which data is used to compute load statistics.
Step 17	`Router (config-if-atm)# no atm ilmi-keepalive`	Disables ILMI keepalive.
Step 18	`Router (config-if-atm)# pvc vpi/vci`	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC and enters ATM VC configuration mode.
Step 19	`Router (config-if-atm-vc)# vbr-rt peak-rate average-rate burst`	Configures the real-time variable bit rate (VBR) for Voice over ATM connections.

	Command	Purpose
Step 20	`Router (config-if-atm-vc)# tx-ring-limit ring-limit`	Limits the number of particles or packets that can be used on a transmission ring on an interface. The *ring-limit* argument specifies the maximum number of allowable particles or packets that can be placed on the transmission ring.
Step 21	`Router (config-if-atm-vc)# protocol protocol {virtual-template {virtual-template-interface-number}| dialer}`	Configures a static map for an ATM PVC, SVC, or VC class or enables Inverse Address Resolution Protocol (ARP) or Inverse ARP broadcasts on an ATM PVC. In this configuration, the *protocol* argument should be **ppp**. If **ppp** is shown as the *protocol* argument, the **virtual-template** keyword and the *virtual-template-interface-number* argument must be used. The *virtual-template-interface-number* argument may be any number from 1 through 200.
Step 22	`Router (config-if-atm-vc)# exit`	Exits ATM VC configuration mode.
Step 23	`Router (config-if)# dsl equipment-type {co | cpe}`	Configures the DSL ATM interface to function as central office equipment or customer premises equipment.
Step 24	`Router (config-if)# dsl operating-mode auto gshdsl symmetric annex {A | B}`	Specifies an operating mode of the digital subscriber line for an ATM interface. **A** specifies North America, and **B** specifies Europe. *A* is the default.
Step 25	`Router (config-if)# dsl linerate {kbps | auto}`	Specifies a line rate for the DSL ATM interface.
Step 26	`Router (config-if)# exit`	Exits interface configuration mode.
Step 27	`Router (config)# interface virtual-template number`	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 28	`Router (config-if)# ip unnumbered type-number`	Enables IP processing on a serial interface without assigning an explicit IP address to the interface. **Note** Use Loopback1 for the *type-number* argument. Loopback is a standard configurtion for MLP over ATM.
Step 29	`Router (config-if)# ip tcp header-compression`	Enables TCP header compression. **Note** When you use the **show running-config** command, the format of the **ip tcp header-compression** command will change to **ip tcp header-compression iphc-format**.
Step 30	`Router (config-if)# service-policy {input | output}`	Attaches a policy map to an input interface or virtual circuit (VC), or to an output interface or VC, to be used as the service policy for that interface or VC. For this configuration, use the **output** keyword.
Step 31	`Router (config-if)# ppp multilink`	Enables MLP on an interface and, optionally, enables Bandwidth Allocation Control Protocol (BACP) and Bandwidth Allocation Protocol (BAP) for dynamic bandwidth allocation.
Step 32	`Router (config-if)# ppp multilink fragment-delay delay-max`	Specifies a maximum size in units of time for packet fragments on a MLP bundle. The *delay-max* argument is the maximum amount of time, in milliseconds, that it should take to transmit a fragment. The range is from 1 to 1000 milliseconds.
Step 33	`Router (config-if)# ppp multilink interleave`	Enables interleaving of packets among the fragments of larger packets on a MLP bundle.

	Command	Purpose
Step 34	`Router (config-if)# ip rtp header-compression [passive]`	Enables Real-Time Transport Protocol (RTP) header compression. The optional **passive** keyword compresses outgoing RTP packets only if incoming RTP packets on the same interface are compressed. **Note** When you enter the **show running-config** command, the format of the **ip rtp header-compression** command will change to **ip rtp header-compression iphc-format**.
Step 35	`Router (config-if)# ip rtp compression-connections number`	Specifies the total number of Real-Time Transport Protocol (RTP) header compression connections that can exist on an interface.
Step 36	`Router (config-if)# exit`	Exits interface configuration mode.
Step 37	`Router (config)# voice-port slot-number/subunit-number/port`	Enters voice-port configuration mode. Enter this command for all ports.
Step 38	`Router (config)# dial-peer voice tag {pots | voatm | vofr | voip}`	Enters dial-peer configuration mode and specifies the method of voice encapsulation, which in this case is POTS**.**
Step 39	`Router (config-dial-peer)# destination-pattern [+] string [T]`	Specifies either the prefix or the full E.164 telephone number (depending on your dial plan) to be used for a dial peer.
Step 40	`Router (config-dial-peer)# port {slot-number/subunit-number/port}`	Associates a dial peer with a specific voice port.
Step 41	`Router (config-dial-peer)# exit`	Exits dial-peer configuration mode.
Step 42	`Router (config)# dial-peer voice tag {pots | voatm | vofr | voip}`	Enters dial-peer configuration mode and specifies the method of voice encapsulation, which in this case is VoIP.
Step 43	`Router (config-dial-peer)# destination-pattern [+] string [T]`	Specifies either the prefix or the full E.164 telephone number (depending on your dial plan) to be used for a dial peer.
Step 44	`Router (config-dial-peer)# session target {ipv4:destination-address}`	Specifies a network-specific address for a specified VoIP dial peer.
Step 45	`Router (config-dial-peer)# dtmf-relay [cisco-rtp] [h245-alphanumeric] [h245-signal]`	Specifies how an H.323 gateway relays dual tone multifrequency (DTMF) tones between telephony interfaces and an IP network.
Step 46	`Router (config-dial-peer)# ip qos dscp [number | set-af | set-cs | default | ef] [media | signaling]`	Specifies IP DSCP. In this case, choose the **media** keyword.
Step 47	`Router (config-dial-peer)# ip qos dscp [number | set-af | set-cs | default | ef] [media | signaling]`	Specifies IP DSCP. In this case, choose the **signaling** keyword.
Step 48	`Router (config-dial-peer)# no vad`	Disables voice activity detection (VAD).

Verifying cRTP Statistics

To display cRTP statistics, use the **show ip rtp header-compression** command as is shown in the following example:

```
Router# show ip rtp header-compression

RTP/UDP/IP header compression statistics:
  Interface Virtual-Template1:
    Rcvd:    0 total, 0 compressed, 0 errors, 0 status msgs
             0 dropped, 0 buffer copies, 0 buffer failures
```

```
    Sent:    0 total, 0 compressed, 0 status msgs
             0 bytes saved, 0 bytes sent
    Connect: 3 rx slots, 3 tx slots,
             0 long searches, 0 misses 0 collisions, 0 negative cache hits

  Interface Virtual-Access4:
    Rcvd:    0 total, 0 compressed, 0 errors, 0 status msgs
             0 dropped, 0 buffer copies, 0 buffer failures
    Sent:    0 total, 0 compressed, 0 status msgs
             0 bytes saved, 0 bytes sent
    Connect: 3 rx slots, 3 tx slots,
             0 long searches, 0 misses 0 collisions, 0 negative cache hits

  Interface Virtual-Access5:
    Rcvd:    7264 total, 7244 compressed, 0 errors, 0 status msgs
             0 dropped, 0 buffer copies, 0 buffer failures
    Sent:    7414 total, 7392 compressed, 0 status msgs
             280706 bytes saved, 164178 bytes sent
             2.70 efficiency improvement factor
    Connect: 3 rx slots, 3 tx slots,
             0 long searches, 2 misses 1 collisions, 0 negative cache hits
             99% hit ratio, five minute miss rate 0 misses/sec, 0 max
```

To display the cRTP gain and to monitor the traffic flow on the actual interface, use the **show interface atm** command.

```
Router# show interface atm 0/0

ATM0/0 is up, line protocol is up
  Hardware is DSLSAR (with Globespan G.SHDSL module)
  MTU 4470 bytes, sub MTU 4470, BW 2304 Kbit, DLY 880 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Encapsulation(s): AAL5 , PVC mode
  23 maximum active VCs, 256 VCs per VP, 1 current VCCs
  VC Auto Creation Disabled.
  VC idle disconnect time: 300 seconds
  Last input 00:11:57, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: None
  30 second input rate 10000 bits/sec, 50 packets/sec
  30 second output rate 13000 bits/sec, 50 packets/sec
     54153 packets input, 2586202 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     5 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     38013 packets output, 2133672 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Configuring FRF.5

To configure FRF.5 for a one-to-one connection between two Frame Relay end users over an intermediate ATM network, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# frame-relay switching`	Enables Frame Relay permanent virtual circuit (PVC) switching.
Step 2	`Router (config)# interface type slot/port`	Enters interface configuration mode.
Step 3	`Router (config-if)# encapsulation frame-relay [ietf]`	Enables Frame Relay encapsulation. Use the **ietf** keyword to set the encapsulation method to comply with the Internet Engineering Task Force (IETF) standard (RFC 1490). Use the **ietf** keyword when connecting to another vendor's equipment across a Frame Relay network.
Step 4	`Router (config-if)# frame-relay interface-dlci dlci switched`	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The *dlci* argument is the DLCI number to be used on the specified interface or subinterface.
Step 5	`Router (config-fr-dlci)# frame-relay intf-type [dce]`	Configures a Frame Relay switch type. Use the **dce** keyword if the router or access server functions as a switch connected to a router.
Step 6	`Router (config-if)# exit`	Exits interface configuration mode.
Step 7	`Router (config)# interface type slot/port.subinterface-number {multipoint | point-to-point}`	Creates an ATM subinterface and enters subinterface configuration mode. The arguments and keywords are as follows: • *type*—Type of interface. Use atm for this configuration. • *slot*—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • *port*—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • *subinterface-number*—Subinterface number in the range 1 to 4294967293. The number that precedes the period (**.**) must match the number to which this subinterfce belongs. • **multipoint**—Multipoint interface. • **point-to-point**—Point-to-point interface.
Step 8	`Router (config-subif)# pvc vpi/vci`	Creates an ATM PVC and enters ATM VC configuration mode. The arguments are as follows: • *vpi*/—ATM network virtual path identifier (VPI) for this PVC. The absence of the "/" and a VPI value defaults the VPI value to 0. • *vci*—ATM network virtual channel identifier (VCI) for this PVC. The VCI is a 16-bit field in the header of the ATM cell. The VCI value is unique only on a single link, not throughout the ATM network, because it has local significance only. **Note** The *vpi* and *vci* arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 9	`Router (config-if-atm-vc)# encapsulation aal5mux frame-relay`	Configures the ATM adaptation layer (AAL) and encapsulation type for an ATM permanent virtual circuit (PVC).
Step 10	`Router (config-if-atm-vc)# exit`	Exits ATM VC configuration mode.
Step 11	`Router (config-subif)# exit`	Exits interface configuration mode.

	Command	Purpose
Step 12	`Router (config)# connect connection-name {FR-interface FR-DLCI} ATM-interface ATM-VPI/VCI [network-interworking]`	Creates a connection to connect the Frame Relay DLCI to the ATM PVC, configures FRF.5 encapsulation, and enters FRF5 configuration mode. The arguments and keywords are as follows: • *connection-name*—Connection name. Enter as a 15-character maximum string. • *FR-interface*—Frame Relay interface type and number, for example, **serial1/0**. • *FR-DLCI*—Frame Relay DLCI in the range from 16 to 1007. • *ATM-interface*—ATM interface type and number, for example, **atm1/0**. • *ATM-VPI/VCI*—ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0. • **network-interworking**—(Optional) FRF.5 network interworking.

Step 13	`Router (config-frf5)# clp-bit {0 | 1 | map-de}`
	or
	`Router (config-frf5)# de-bit map-clp`
		Sets the ATM cell loss priority (CLP) bit field in the ATM cell header.
		or
		Sets the discard eligible (DE) bit mapping from ATM to Frame Relay.

To configure FRF.5 for a many-to-one connection between two Frame Relay end users over an intermediate ATM network, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# frame-relay switching`	Enables Frame Relay permanent virtual circuit (PVC) switching.
Step 2	`Router (config)# interface type slot/port`	Enters interface configuration mode.
Step 3	`Router (config-if)# encapsulation frame-relay [ietf]`	Enables Frame Relay encapsulation. Use the **ietf** keyword to set the encapsulation method to comply with the Internet Engineering Task Force (IETF) standard (RFC 1490). Use the **ietf** keyword when connecting to another vendor's equipment across a Frame Relay network.
Step 4	`Router (config-if)# frame-relay interface-dlci dlci switched`	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The *dlci* argument is the DLCI number to be used on the specified interface or subinterface.
Step 5	`Router (config-fr-dlci)# frame-relay intf-type [dce]`	Configures a Frame Relay switch type. Use the **dce** keyword if the router or access server functions as a switch connected to a router.
Step 6	`Router (config-if)# exit`	Exits interface configuration mode.
Step 7	`Router (config)# vc-group group-name`	Assigns multiple Frame Relay DLCIs to a VC group and enters ATM-Frame Relay VC group configuration mode.

	Command	Purpose
Step 8	`Router (config-vc-group)#` **`FR-interface-name FR-DLCI FR-SSCS-DLCI`**	Specifies the Frame Relay DLCIs in the VC group and maps them to the Frame Relay-SSCS DLCIs.
Step 9	`Router (config-vc-group)#` **`exit`**	Exits ATM-Frame Relay VC group configuration mode.
Step 10	`Router (config)#` **`interface atm`** *slot*/*port*.*subinterface-number* {**`multipoint`** | **`point-to-point`**}	Creates an ATM subinterface and enters subinterface configuration mode. The arguments and keywords are as follows: • *slot*—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • *port*—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • *subinterface-number*—Subinterface number in the range 1 to 4294967293. The number that precedes the period (**.**) must match the number to which this subinterfce belongs. • **multipoint**—Multipoint interface. • **point-to-point**—Point-to-point interface.
Step 11	`Router (config-subif)#` **`pvc`** *vpi*/*vci*	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC. The arguments are as follows: • *vpi*/—ATM network virtual path identifier (VPI) for this PVC. The absence of the "/" and a VPI value defaults the VPI value to 0. • *vci*— ATM network virtual channel identifier (VCI) for this PVC. The VCI is a 16-bit field in the header of the ATM cell. The VCI value is unique only on a single link, not throughout the ATM network, because it has local significance only. The *vpi* and *vci* arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 12	`Router (config-if-atm-vc)#` **`encapsulation aal5mux frame-relay`**	Configures the ATM adaptation layer (AAL) and encapsulation type for an ATM permanent virtual circuit (PVC) and enters ATM VC configuration mode.
Step 13	`Router (config-if-atm-vc)#` **`exit`**	Exits ATM VC configuration mode.
Step 14	`Router (config-if)#` **`exit`**	Exits interface configuration mode.

	Command	Purpose
Step 15	`Router (config)# connect` *connection-name* **vc-group** *group-name ATM-interface ATM-VPI/VCI*	Configures an FRF.5 one-to-one connection between two Frame Relay end users over an intermediate ATM network and enters FRF.5 configuration mode. The arguments and keywords are as follows: • *connection-name*—A connection name. Enter as a 15-character maximum string. • **vc-group**—Specifies a VC group name for a many-to-one FRF.5 connection. Enter as an 11- character maximum string. • *ATM-interface*—The ATM interface type and number, for example, **atm1/0**. • *ATM-VPI/VCI*—The ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0.

Step 16	`Router (config-frf5)# clp-bit {0 | 1 | map-de}`
	or
	`Router (config-frf5)# de-bit map-clp`
		Sets the ATM cell loss priority (CLP) bit field in the ATM cell header.
		or
		Sets the discard eligible (DE) bit mapping from ATM to Frame Relay.

Verifying FRF.5

The following **show** command output is from a Cisco 1721 router. Use the **show connection all** or **show connection id** commands to check the state of the connection. Use the **show frame-relay pvc** command to verify the state of the Frame Relay PVC, and use the **show atm pvc** command to verify the state of the ATM PVC.

```
Router# show connection all

ID   Name               Segment 1            Segment 2           State
========================================================================
1    frf5              Serial0 100          ATM0 0/33           UP


Router# show connection id 1

FR/ATM Network Interworking Connection: frf5
  Status    - UP
  Segment 1 - Serial0 DLCI 100
  Segment 2 - ATM0 VPI 0 VCI 33
  Interworking Parameters -
    fr-sscs-dlci 1022
    de-bit map-clp
    clp-bit map-de


Router# show frame-relay pvc 100

PVC Statistics for interface Serial0 (Frame Relay DCE)

DLCI = 100, DLCI USAGE = FRF.5, PVC STATUS = ACTIVE, INTERFACE = Serial0

  input pkts 5             output pkts 5            in bytes 520
```

```
  out bytes 520            dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  switched pkts 5
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 00:25:00, last time pvc status changed 00:05:16
```

```
Router# show atm pvc 0/33

ATM0.1: VCD: 1, VPI: 0, VCI: 33
UBR, PeakRate: 2304
AAL5-FRATM, etype:0x3, Flags: 0xC22, VCmode: 0x0
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM END CC Activate retry count: 3, OAM END CC Deactivate retry count: 3
OAM END CC retry frequency: 30 second(s),
OAM SEGMENT CC Activate retry count: 3, OAM SEGMENT CC Deactivate retry count: 3
OAM SEGMENT CC retry frequency: 30 second(s),
OAM Loopback status: OAM Disabled
OAM VC state: Not Managed
ILMI VC state: Not Managed
InARP DISABLED
InPkts: 5, OutPkts: 5, InBytes: 540, OutBytes: 540
InPRoc: 0, OutPRoc: 0
InFast: 5, OutFast: 5, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0/0/0 (holdq/outputq/total)
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0, LengthViolation: 0, CPIErrors: 0
Out CLP=1 Pkts: 0
OAM cells received: 0
F5 InEndloop: 0, F5 InSegloop: 0,
F5 InEndcc: 0, F5 InSegcc: 0, F5 InAIS: 0, F5 InRDI: 0
F4 InEndloop: 0, F4 InSegloop: 0, F4 InAIS: 0, F4 InRDI: 0
OAM cells sent: 0
F5 OutEndloop: 0, F5 OutSegloop: 0,
F5 OutEndcc: 0, F5 OutSegcc: 0, F5 OutRDI: 0
F4 OutEndloop: 0, F4 OutSegloop: 0, F4 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Configuring FRF.8

To configure FRF.8, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# frame-relay switching`	Enables Frame Relay permanent virtual circuit (PVC) switching.
Step 2	`Router (config)# interface serial` *slot*`/`*port*	Enters interface configuration mode.

	Command	Purpose
Step 3	`Router (config-if)# encapsulation frame-relay [ietf]`	Enables Frame Relay encapsulation. Use the **ietf** keyword to set the encapsulation method to comply with the Internet Engineering Task Force (IETF) standard (RFC 1490). Use this keyword when connecting to another vendor's equipment across a Frame Relay network.
Step 4	`Router (config-if)# no fair-queue`	Deletes the configured number of queues from the traffic class.
Step 5	`Router (config-if)# frame-relay interface-dlci dlci switched`	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The *dlci* argument is the DLCI number to be used on the specified interface or subinterface.
Step 6	`Router (config-fr-dlci)# frame-relay intf-type dce`	Configures a Frame Relay switch type. Use the **dce** keyword if the router or access server functions as a switch connected to a router.
Step 7	`Router (config-if)# exit`	Exits interface configuration mode.
Step 8	`Router (config)# interface type slot/port.subinterface-number {multipoint | point-to-point}`	Configures an interface type and enters subinterface configuration mode. The arguments and keywords are as follows: • *type*—To configure FRF.8, use atm for the *type* argument. • *slot*—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • *port*—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • *subinterface-number*—Subinterface number in the range 1 to 4294967293. The number that precedes the period (.) must match the number to which this subinterface belongs. • **multipoint**—Multipoint interface. • **point-to-point**—Point-to-point interface.
Step 9	`Router (config-subif)# pvc vpi/vci`	Creates an ATM PVC, assigns a name to an ATM PVC, and enters ATM VC configuration mode. The arguments are as follows: • *vpi*/—ATM network virtual path identifier (VPI) for this PVC. The absence of the "/" and a VPI value defaults the VPI value to 0. • *vci*—ATM network virtual channel identifier (VCI) for this PVC. The VCI is a 16-bit field in the header of the ATM cell. The VCI value is unique only on a single link, not throughout the ATM network, because it has local significance only. The *vpi* and *vci* arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 10	`Router (config-if-atm-vc)# encapsulation aal5mux fr-atm-srv`	Configures the ATM adaptation layer (AAL) and encapsulation type for an ATM PVC.
Step 11	`Router (config-if-atm-vc)# exit`	Exits ATM VC configuration mode.
Step 12	`Router (config-if) exit`	Exits interface configuration mode.

	Command	Purpose
Step 13	`Router (config)# connect connection-name FR-interface FR-DLCI ATM-interface ATM-VPI/VCI service-interworking`	Configures an FRF.8 one-to-one mapping between a Frame Relay DLCI and an ATM permanent virtual circuit (PVC) and enters FRF.8 configuration mode. The arguments and keywords are as follows: • *connection-name*–Connection name. Enter as a 15-character maximum string. • *FR-interface*—Frame Relay interface type and number, for example, **serial1/0**. • *FR-DLCI*—Frame Relay data-link connection identifier (DLCI) in the range 16 to 1007. • *ATM-interface*— ATM interface type and number, for example **atm1/0**. • *ATM-VPI/VCI*—ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0. • **service-interworking**—FRF.8 service interworking.

Step 14	`Router (config-frf8)# clp-bit {0 | 1 | map-de}`
	or
	`Router (config-frf8)# de-bit {0 | 1 | map-clp}`
	or
	`Router (config-frf8)# efci-bit {0 | map-fecn}`
		Sets the ATM cell loss priority (CLP) bit field in the ATM cell header.
		or
		Sets the Frame Relay discard eligible (DE) bit field in the Frame Relay header.
		or
		Sets the explicit forward congestion indication (EFCI) bit field in the ATM cell header.

Verifying FRF.8

The following **show** command output is from a Cisco 1721 router. Use the **show connection all** or **show connection id** commands to check the state of the connection. Use **show frame-relay pvc** command to verify the state of the Frame Relay PVC and use **show atm pvc** command to verify the state of the ATM PVC.

```
Router# show connection all

ID   Name               Segment 1            Segment 2           State
========================================================================
2    frf8              Serial0 100          ATM0 0/33           UP


Router# show connection id 2

FR/ATM Service Interworking Connection: frf8
  Status    - UP
  Segment 1 - Serial0 DLCI 100
  Segment 2 - ATM0 VPI 0 VCI 33
Interworking Parameters -
    service translation
```

```
    efci-bit 0
    de-bit map-clp
    clp-bit map-de


Router# show frame-relay pvc

PVC Statistics for interface Serial0 (Frame Relay DCE)

              Active     Inactive      Deleted       Static
  Local          0            0            0            0
  Switched       1            0            0            0
  Unused         0            0            0            0

DLCI = 100, DLCI USAGE = FRF.8, PVC STATUS = ACTIVE, INTERFACE = Serial0

  input pkts 5             output pkts 5            in bytes 540
  out bytes 520            dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  switched pkts 5
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 00:08:57, last time pvc status changed 00:08:20


Router# show atm pvc 0/33

ATM0.1: VCD: 1, VPI: 0, VCI: 33
UBR, PeakRate: 2304
AAL5-FRATMSRV, etype:0x15, Flags: 0xC23, VCmode: 0x0
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM END CC Activate retry count: 3, OAM END CC Deactivate retry count: 3
OAM END CC retry frequency: 30 second(s),
OAM SEGMENT CC Activate retry count: 3, OAM SEGMENT CC Deactivate retry count: 3
OAM SEGMENT CC retry frequency: 30 second(s),
OAM Loopback status: OAM Disabled
OAM VC state: Not Managed
ILMI VC state: Not Managed
InARP DISABLED
InPkts: 5, OutPkts: 5, InBytes: 560, OutBytes: 560
InPRoc: 0, OutPRoc: 0
InFast: 5, OutFast: 5, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0/0/0 (holdq/outputq/total)
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0, LengthViolation: 0, CPIErrors: 0
Out CLP=1 Pkts: 0
OAM cells received: 0
F5 InEndloop: 0, F5 InSegloop: 0,
F5 InEndcc: 0, F5 InSegcc: 0, F5 InAIS: 0, F5 InRDI: 0
F4 InEndloop: 0, F4 InSegloop: 0, F4 InAIS: 0, F4 InRDI: 0
OAM cells sent: 0
F5 OutEndloop: 0, F5 OutSegloop: 0,
F5 OutEndcc: 0, F5 OutSegcc: 0, F5 OutRDI: 0
F4 OutEndloop: 0, F4 OutSegloop: 0, F4 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Configuring MLP Bundling

To configure MLP bundling using a multilink interface, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# interface multilink multilink-bundle-number`	Creates a multilink bundle or enters multilink interface configuration mode. The *multilink-bundle-number* argument is the number of the multilink bundle (a nonzero number).
Step 2	`Router (config-if)# ip address ip-address mask [secondary]`	Sets a primary or secondary IP address for an interface.
Step 3	`Router (config-if)# service-policy output {input | output} policy-map-name`	Attaches a policy map to an input interface or virtual circuit (VC), or to an output interface or VC, to be used as the service policy for that interface or VC.
Step 4	`Router (config-if)# ppp multilink`	Enables Multilink PPP (MLP) on an interface and, optionally, enables Bandwidth Allocation Control Protocol (BACP) and Bandwidth Allocation Protocol (BAP) for dynamic bandwidth allocation.
Step 5	`Router (config-if)# ppp multilink fragment-delay delay-max`	Specifies a maximum size in units of time for packet fragments on a MLP bundle. The *delay-max* argument is the maximum amount of time, in milliseconds, that it should take to transmit a fragment. The range is from 1 to 1000 milliseconds.
Step 6	`Router (config-if)# ppp multilink interleave`	Enables interleaving of packets among the fragments of larger packets on an MLP bundle.
Step 7	`Router (config)# interface virtual-template number`	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces and enters interface configuration mode. The *number* argument is the number used to identify the virtual template interface. Up to 200 virtual template interfaces can be configured.
Step 8	`Router (config-if)# no ip address`	Removes an IP address or disables IP processing.
Step 9	`Router (config-if)# ppp multilink`	Enables MLP on an interface and, optionally, enables BACP and BAP for dynamic bandwidth allocation..
Step 10	`Router (config-if)# ppp multilink multiclass`	Allows interleaving to be used on bundles that consist of more than one link. For Point-to-Point Protocol over ATM (PPPoA) and Point-to-Point Protocol over Frame Relay (PPPoFR), the command is entered on the virtual template.
Step 11	`Router (config-if)# ppp multilink group group-number`	Restricts a physical link to joining only a designated multilink-group interface. The *group-number* argument is a multilink-group number (a nonzero number).
Step 12	`Router (config-if)# exit`	Exits interface configuration mode.
Step 13	`Router (config)# interface type slot/port.subinterface-number [point-to-point]`	Configures an interface type and enters interface configuration mode. The *type* argument should be ATM.
Step 14	`Router (config-if)# pvc vpi/vci`	Creates an ATM PVC or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode.

	Command	Purpose
Step 15	`Router (config-if-atm-vc)# vbr-rt peak-rate average-rate burst`	Configures the real-time variable bit rate (VBR) for Voice over ATM connections.
Step 16	`Router (config-if-atm-vc)# tx-ring-limit ring-limit`	Limits the number of packets that can be used on a transmission ring on the PVC. The *ring-limit* argument is the maximum number of allowable packets that can be placed on the transmission ring. The default value is 60. On Cisco 1700 series routers, possible values are 2 through 60. On Cisco 2600 and Cisco 3600 series routers, possible values are 3 through 60.
Step 17	`Router (config-if-atm-vc)# protocol protocol protocol-address`	Configures a static map for an ATM PVC, switched virtual circuit (SVC), or VC class or enables Inverse Address Resolution Protocol (ARP) or Inverse ARP broadcasts on an ATM PVC. The *protocol* argument should be PPP. The *protocol-address* argument should be virtual-template1 (the destination address that is being mapped to a PVC).
Step 18	`Router (config-if-atm-vc)# exit`	Exits interface ATM VC configuration mode.
Step 19	`Repeat Steps 13 through 18 to create another MLP bundle.`	—

Verifying MLP Bundling

To verify your MLP bundling configuration, use the following **show** commands:

```
Router# show ppp multilink

Multilink1, bundle name is 3660
  Bundle up for 00:00:17E, 1/255 load, 2 receive classes, 2 transmit classes
  Receive Class 0:
    1 lost fragments, 1 reordered, 0 unassigned
    0 discarded, 0 lost received
    0x3 received sequence
  Receive Class 1:
    0 lost fragments, 0 reordered, 0 unassigned
    0 discarded, 0 lost received
    0x0 received sequence
  Transmit Class 0:
    0x2 sent sequence
  Transmit Class 1:
    0x0 sent sequence
  Member links: 2 active, 5 inactive (max not set, min not set)
    Vi8, since 00:00:17  480 weight, 472 frag size
    Vi9, since 00:00:17  480 weight, 472 frag size


Router# show interfaces multilink 1

Multilink1 is up, line protocol is up
  Hardware is multilink group interface
  Interface is unnumbered. Using address of Loopback0 (2.2.2.2)
  MTU 1500 bytes, BW 1280 Kbit, DLY 100000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open, multilink Open
  Open: IPCP, loopback not set
  DTR is pulsed for 2 seconds on reset
```

```
  Last input 02:57:52, output never, output hang never
  Last clearing of "show interface" counters 02:58:45
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     Available Bandwidth 860 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     2 packets input, 28 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     2 packets output, 24 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions


Router# show interfaces atm 0/0

ATM0/0 is up, line protocol is up
  Hardware is DSLSAR (with Alcatel ADSL Module)
  MTU 4470 bytes, sub MTU 4470, BW 800 Kbit, DLY 2560 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Encapsulation(s): AAL5  AAL2, PVC mode
  23 maximum active VCs, 256 VCs per VP, 1 current VCCs
  VC Auto Creation Disabled.
  VC idle disconnect time: 300 seconds
  Last input never, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: None
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     2188 packets input, 30640 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     4 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     2194 packets output, 48368 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out


Router# show users

    Line       User       Host(s)              Idle       Location
*   0 con 0                 idle                 00:00:00

  Interface    User               Mode         Idle      Peer Address
  Vi4          3660            PPPoATM      00:09:25
  Vi5          3660            PPPoATM      00:09:23
  Mu1         3660              Sync PPP     00:09:25  2.2.2.2


Router# show policy-map interface mul 1

 Multilink1

  Service-policy output: CISCO

    Class-map: VOICE (match-all)
      11117 packets, 234235 bytes
      30 second offered rate 25000 bps, drop rate 0 bps
```

```
      Match: access-group 100
      Queueing
        Strict Priority
        Output Queue: Conversation 264
        Bandwidth 100 (kbps) Burst 2500 (Bytes)
        (pkts matched/bytes matched) 17/748
        (total drops/bytes drops) 0/0

    Class-map: class-default (match-any)
      234453438 packets, 64564574574bytes
      30 second offered rate 645000 bps, drop rate 12000 bps
      Match: any


Router# show dsl interface atm 0/0

Alcatel 20150 chipset information
                ATU-R (DS)                      ATU-C (US)
Modem Status:    Showtime (DMTDSL_SHOWTIME)
DSL Mode:        ITU G.992.1 (G.DMT)
ITU STD NUM:     0x01                            0x1
Vendor ID:       'ALCB'                          'GSPN'
Vendor Specific: 0x0000                          0x0002
Vendor Country:  0x00                            0x00
Capacity Used:   80%                             90%
Noise Margin:    11.5 dB                          9.0 dB
Output Power:     8.0 dBm                        12.0 dBm
Attenuation:      0.0 dB                          4.0 dB
Defect Status:   None                            None
Last Fail Code:  Handshake or init message invalid or had bad CRC
Selftest Result: 0x00
Subfunction:     0x15
Interrupts:      1333 (0 spurious)
PHY Access Err:  0
Activations:     1
Init FW:         embedded
Operation FW:    embedded
SW Version:      3.8129
FW Version:      0x1A04

                 Interleave              Fast    Interleave              Fast
Speed (kbps):          7616                 0           800                 0
Reed-Solomon EC:          4                 0          1326                 0
CRC Errors:               0                 0             1                 0
Header Errors:            0                 0             0                 0
Bit Errors:               0                 0
BER Valid sec:            0                 0
BER Invalid sec:          0                 0

DMT Bits Per Bin
00: 0 0 0 0 0 0 0 6 7 8 9 9 B B C C
10: B B C C B B A 9 9 9 9 8 8 9 0 0
20: 0 0 0 0 0 0 3 4 4 5 6 6 7 7 7 8
30: 8 8 9 9 9 9 A A A A A A A A 9 A
40: 0 B B B B B B B B B B B B B B B
50: B B B B B B B B B B B B 8 B 2
60: B B B B B B B B B B B B B B B
70: B B B B B B 8 B B B B B 9 B B B
80: B B B B B B B B B B B B B B B B
90: B B B B B B B B B B 9 B B B B
A0: B B B B B B B B B B B B B B B
B0: B B B B B B A B B A 9 A A A A A
C0: A A A A A A A A A A A A A A A A
D0: A A A A A A A A A 9 A A A A A A
```

```
E0: A A A A A A 9 A 9 9 8 8 7 5 5 5
F0: 4 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0

DSL: Training log buffer capability is not enabled
```

Troubleshooting Tips for MLP Bundling

To troubleshoot your MLP bundling configuration, do the following:

Step 1 Verify the status of the multilink interface using the **show interface multilink** command.

- If the multilink interface is down, verify the status of all multilink bundle members using the **show ppp multilink** command.
- If the multilink line protocol is down, verify the Network Control Protocol (NCP) and MLP messages using the **debug ppp negotiation** and **debug ppp multilink events** commands.

Step 2 If a multilink member is inactive, verify the status of the ATM interface using the **show interface atm** command.

- If the ATM interface is down, verify the status of the corresponding DSL link using the **show dsl interface atm** command.

Step 3 Check all Link Control Protocol (LCP) and Network Control Program (NCP) negotiation messages using the **debug ppp negotiation** command (see the following output example).

```
Router# debug ppp negotiation

1d05h: ppp11 LCP: State is Open
1d05h: ppp11 PPP: Phase is FORWARDING, Attempting Forward
1d05h: Vi7 PPP: Phase is DOWN, Setup
1d05h: Vi7 PPP: Phase is DOWN, Setup
1d05h: ppp11 LCP: I TERMREQ [Open] id 2 len 4
1d05h: ppp11 LCP: O TERMACK [Open] id 2 len 4
1d05h: ppp11 PPP: Phase is TERMINATING
1d05h: ppp13 PPP: Treating connection as a dedicated line
1d05h: ppp13 PPP: Phase is ESTABLISHING, Active Open
1d05h: ppp13 LCP: O CONFREQ [Closed] id 1 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 PPP: Treating connection as a dedicated line
1d05h: ppp14 PPP: Phase is ESTABLISHING, Active Open
1d05h: ppp14 LCP: O CONFREQ [Closed] id 1 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: TIMEout: State REQsent
1d05h: ppp13 LCP: O CONFREQ [REQsent] id 2 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: TIMEout: State REQsent
1d05h: ppp14 LCP: O CONFREQ [REQsent] id 2 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
```

```
1d05h: ppp13 LCP: TIMEout: State REQsent
1d05h: ppp13 LCP: O CONFREQ [REQsent] id 3 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: TIMEout: State REQsent
1d05h: ppp14 LCP: O CONFREQ [REQsent] id 3 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: TIMEout: State REQsent
1d05h: ppp13 LCP: O CONFREQ [REQsent] id 4 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: TIMEout: State REQsent
1d05h: ppp14 LCP: O CONFREQ [REQsent] id 4 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: I CONFREQ [REQsent] id 1 len 29
1d05h: ppp13 LCP:    MagicNumber 0x36EBFBB7 (0x050636EBFBB7)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 3660 (0x130B01333636302D746F70)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: O CONFACK [REQsent] id 1 len 29
1d05h: ppp13 LCP:    MagicNumber 0x36EBFBB7 (0x050636EBFBB7)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 3660 (0x130B01333636302D746F70)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: I CONFREQ [REQsent] id 1 len 29
1d05h: ppp14 LCP:    MagicNumber 0x36EBFBB8 (0x050636EBFBB8)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 3660 (0x130B01333636302D746F70)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: O CONFACK [REQsent] id 1 len 29
1d05h: ppp14 LCP:    MagicNumber 0x36EBFBB8 (0x050636EBFBB8)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 3660 (0x130B01333636302D746F70)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: TIMEout: State ACKsent
1d05h: ppp13 LCP: O CONFREQ [ACKsent] id 5 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: I CONFACK [ACKsent] id 5 len 29
1d05h: ppp13 LCP:    MagicNumber 0x0FD2BAA3 (0x05060FD2BAA3)
1d05h: ppp13 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp13 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp13 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp13 LCP: State is Open
1d05h: ppp13 PPP: Phase is FORWARDING, Attempting Forward
1d05h: Vi8 PPP: Phase is DOWN, Setup
1d05h: Vi8 PPP: Phase is DOWN, Setup
1d05h: ppp13 PPP MLP: Queue packet code[192] id[0]
1d05h: %LINK-3-UPDOWN: Interface Virtual-Access8, changed state to up
1d05h: Vi8 PPP: Phase is ESTABLISHING, Finish LCP
1d05h: Vi8 PPP: Phase is VIRTUALIZED
1d05h: Mu1 MLP: Added first link Vi8 to bundle 3660
```

```
1d05h: Vi8 PPP: Process pending packets
1d05h: Vi8 MLP: Redirect packet to MLP
1d05h: %LINK-3-UPDOWN: Interface Multilink1, changed state to up
1d05h: Mu1 PPP: Phase is UP
1d05h: Mu1 IPCP: O CONFREQ [Closed] id 2 len 10
1d05h: Mu1 IPCP:    Address 2.2.2.2 (0x030602020202)
1d05h: Mu1 PPP: Process pending packets
1d05h: Mu1 PPP: Process pending packets
1d05h: Mu1 PPP: Treating connection as a dedicated line
1d05h: Mu1 IPCP: I CONFACK [REQsent] id 2 len 10
1d05h: Mu1 IPCP:    Address 2.2.2.2 (0x030602020202)
1d05h: ppp14 LCP: TIMEout: State ACKsent
1d05h: ppp14 LCP: O CONFREQ [ACKsent] id 5 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: I CONFACK [ACKsent] id 5 len 29
1d05h: ppp14 LCP:    MagicNumber 0x0FD2BB2D (0x05060FD2BB2D)
1d05h: ppp14 LCP:    MRRU 1524 (0x110405F4)
1d05h: ppp14 LCP:    EndpointDisc 1 2600 (0x130B0132363531584D2D31)
1d05h: ppp14 LCP:    MultilinkHdrFmt seq long classes 2 (0x1B040202)
1d05h: ppp14 LCP: State is Open
1d05h: ppp14 PPP: Phase is FORWARDING, Attempting Forward
1d05h: Vi9 PPP: Phase is DOWN, Setup
1d05h: Vi9 PPP: Phase is DOWN, Setup
1d05h: %LINK-3-UPDOWN: Interface Virtual-Access9, changed state to up
1d05h: Vi9 PPP: Phase is ESTABLISHING, Finish LCP
 1d05h: Vi9 PPP: Phase is VIRTUALIZED
1d05h: Mu1 MLP: Added link Vi9 to bundle 3660
1d05h: Vi9 PPP: Process pending packets
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access8, changed state to
up
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Multilink1, changed state to up
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access9, changed state to
up
1d05h: Mu1 IPCP: I CONFREQ [ACKrcvd] id 8 len 10
1d05h: Mu1 IPCP:    Address 2.2.2.3 (0x030602020203)
1d05h: Mu1 AAA/AUTHOR/IPCP: Start.  Her address 2.2.2.3, we want 0.0.0.0
1d05h: Mu1 AAA/AUTHOR/IPCP: Reject 2.2.2.3, using 0.0.0.0
1d05h: Mu1 AAA/AUTHOR/IPCP: Done.  Her address 2.2.2.3, we want 0.0.0.0
1d05h: Mu1 IPCP: O CONFACK [ACKrcvd] id 8 len 10
1d05h: Mu1 IPCP:    Address 2.2.2.3 (0x030602020203)
1d05h: Mu1 IPCP: State is Open
1d05h: Mu1 IPCP: Install route to 2.2.2.3
1d05h: Mu1 IPCP: Add link info for cef entry 2.2.2.3
```

Step 4 Check all Challenge Handshake Authentication Protocol (CHAP) authentication messages using the **debug ppp authentication** command (see the following output example).

```
Router# debug ppp authentication

1d06h: ppp295 PPP: Treating connection as a dedicated line
1d06h: ppp295 PPP: Authorization required
1d06h: ppp296 PPP: Treating connection as a dedicated line
1d06h: ppp296 PPP: Authorization required
1d06h: ppp295 CHAP: O CHALLENGE id 1 len 29 from "3660"
1d06h: ppp295 CHAP: I CHALLENGE id 1 len 29 from "2600"
1d06h: ppp295 CHAP: Using hostname from unknown source
1d06h: ppp295 CHAP: Using password from AAA
1d06h: ppp295 CHAP: O RESPONSE id 1 len 29 from "3660"
1d06h: ppp295 CHAP: I RESPONSE id 1 len 29 from "2600"
1d06h: ppp295 PPP: Sent CHAP LOGIN Request
1d06h: ppp295 PPP: Received LOGIN Response PASS
```

```
1d06h: %LINK-3-UPDOWN: Interface Virtual-Access4, changed state to up
1d06h: Vi4 CHAP: O SUCCESS id 1 len 4
1d06h: Vi4 CHAP: I SUCCESS id 1 len 4
1d06h: %LINK-3-UPDOWN: Interface Multilink1, changed state to up
1d06h: Mu1 PPP: Treating connection as a dedicated line
1d06h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access4, changed state to
up
1d06h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Multilink1, changed state to up
1d06h: ppp296 CHAP: O CHALLENGE id 1 len 29 from "3660" ç
1d06h: ppp296 CHAP: I CHALLENGE id 1 len 29 from "2600" ç
1d06h: ppp296 CHAP: Using hostname from unknown source
1d06h: ppp296 CHAP: Using password from AAA
1d06h: ppp296 CHAP: O RESPONSE id 1 len 29 from "3660"
1d06h: ppp296 CHAP: I RESPONSE id 1 len 29 from "2600"
1d06h: ppp296 PPP: Sent CHAP LOGIN Request
1d06h: ppp296 PPP: Received LOGIN Response PASS ç
1d06h: %LINK-3-UPDOWN: Interface Virtual-Access5, changed state to up
1d06h: Vi5 CHAP: O SUCCESS id 1 len 4
1d06h: Vi5 CHAP: I SUCCESS id 1 len 4
1d06h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access5, changed state to
up
```

Step 5 Check all MLP bundle events using the **debug ppp multilink events** command (see the following output example).

```
Router# debug ppp multilink events

1d05h: %LINK-3-UPDOWN: Interface Virtual-Access8, changed state to up
1d05h: %LINK-3-UPDOWN: Interface Virtual-Access9, changed state to up
1d05h: Vi8 MLP: Request add link to bundle
1d05h: Vi9 MLP: Request add link to bundle
1d05h: Vi8 MLP: Adding link to bundle
1d05h: Mu1 MLP: Added first link Vi8 to bundle 3660 1d05h: Vi9 MLP: Adding link to bundle
1d05h: Mu1 MLP: Added link Vi9 to bundle 3660
1d05h: %LINK-3-UPDOWN: Interface Multilink1, changed state to up
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access8, changed state to
up
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access9, changed state to
up
1d05h: %LINEPROTO-5-UPDOWN: Line protocol on Interface Multilink1, changed st
```

Configuring the Tx Ring Limit

To configure the tx ring limit, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router (config)# interface atm slot/port`	Configures an ATM interface type and enters interface configuration mode.
Step 2	`Router (config-if)# pvc [name] vpi/vci [ces | ilmi | qsaal | smds]`	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode.

	Command	Purpose

Step 3	`Router (config-if-atm-vc)# vbr-rt peak-rate average-rate burst`
	
	or
	
	`Router (config-if-atm-vc)# vbr-nrt output-pcr output-scr output-mbs [input-pcr] [input-scr] [input-mbs]`
		Configures the real-time variable bit rate (VBR) for Voice over ATM connections.
		
		or
		
		Configures the variable bit rate-nonreal time (VBR-NRT) quality of service (QoS) and specifies output peak cell rate (PCR), output sustainable cell rate (SCR), and output maximum burst cell size for an ATM permanent virtual circuit (PVC), PVC range, switched virtual circuit (SVC), VC class, or VC bundle member.
		
		Note The **tx-ring-limit** command needs to be used with either the **vbr-rt** command or the **vbr-nrt** command and also in conjunction with low latency queueing (LLQ).

Step 4	`Router (config-if-atm-vc)# tx-ring-limit ring-limit`	Limits the number of packets that can be used on a transmission ring on the permanent virtual circuit (PVC). The argument is as follows: • *ring-limit*—Maximum number of allowable packets that can be placed on the transmission ring. The default value is 60. On Cisco 1700 series routers, possible values are 2 through 60. On Cisco 2600 and Cisco 3600 series routers, possible values are 3 through 60.

Verifying the Tx Ring Limit

The following output example is for a tx ring limit over ADSL configuration:

```
Router# show running-config

interface ATM0/0
 no ip address
 load-interval 30
 no atm ilmi-keepalive
 pvc 1/100
  vbr-rt 1500 1500
  tx-ring-limit 3
  protocol ppp Virtual-Template1
 !
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
```

Configuration Examples

This section provides the following configuration examples for ADSL and G.SHDSL:

- ATM CLP Bit Marking over G.SHDSL Example
- Clock Rate for ADSL and G.SHDSL WICs Example
- cRTP over an ATM Link with PPP Encapsulation Example
- FRF.5 over G.SHDSL Example
- FRF.8 over G.SHDSL Example
- MLP Bundling Example
- Tx Ring-Limit Tuning over ADSL Example

ATM CLP Bit Marking over G.SHDSL Example

The following output is from a Cisco 1721 router. In this example, all output packets that have an IP precedence value of 0 are sent with the CLP set to 1.

Note

- IP Cisco Express Forwarding (IP CEF) must be turned on using the **ip cef** command-line interface before ATM CLP bit marking is configured.
- ATM CLP bit marking can be applied only as output policy for an interface.

```
ip cef
!
class-map match-all PREC0
 match ip precedence 0

!
policy-map ATM_CLP
 class PREC0
  set atm-clp
!
interface ATM0
 no ip address
 no atm ilmi-keepalive
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
interface ATM0.1 point-to-point
 ip address 10.0.0.1 255.255.255.0
 pvc 0/33
  service-policy output ATM_CLP
```

Clock Rate for ADSL and G.SHDSL WICs Example

The following example from a Cisco 1760 router shows that the clock rate on the AAL5 channel is set to the minimum value of 4 Mbps on interface ATM 0/0:

```
interface atm 0/0
 clock rate aal5 4000000
```

The following example from a Cisco 1760 router shows that the clock rate on the AAL2 channel is set to the value of 5.3 Mbps on interface ATM 1/0:

```
interface atm 1/0
 clock rate aal2 5300000
```

The following example from a Cisco 2621 mainboard module shows that the clock rate on the AAL5 channel is set to the maximum value of 7 Mbps on interface ATM 0/0:

```
interface atm 0/0
 clock rate aal5 7000000
```

The following example from a Cisco 2621 network module shows that the clock rate on the AAL5 channel is set to the maximum value of 5.3 Mbps on interface ATM 1/0:

```
interface atm 1/0
 clock rate aal5 5300000
```

cRTP over an ATM Link with PPP Encapsulation Example

The following example shows that cRTP has been configured using Virtual Template over ATM:

```
ip cef
class-map match-all voice-traffic
 match access-group 102
class-map match-all voice-signalling
 match access-group 103
!
policy-map VOICE-POLICY
 class voice-traffic
  priority 48
 class voice-signalling
  bandwidth 8
 class class-default
  fair-queue
!
interface Loopback0
 ip address 192.168.1.2 255.255.255.0
!
interface ATM0/0
 no ip address
 load-interval 30
 no atm ilmi-keepalive
 pvc 1/100
  vbr-rt 1500 1500
  tx-ring-limit 3
  protocol ppp Virtual-Template1
!
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
interface Virtual-Template1
 ip unnumbered Loopback0
 ip tcp header-compression iphc-format
 service-policy output VOICE-POLICY
 ppp multilink
 ppp multilink fragment-delay 3
 ppp multilink interleave
 ip rtp header-compression iphc-format
 ip rtp compression-connections 3
```

```
!
access-list 102 permit udp any any range 16384 37276
access-list 103 permit tcp any eq 1720 any
access-list 103 permit tcp any any eq 1720
!
voice-port 1/0/0
!
voice-port 1/0/1
!
dial-peer voice 1 pots
 destination-pattern 7...
 port 1/0/0
!
dial-peer voice 2 voip
 destination-pattern 8...
 session target ipv4:192.168.1.1
dtmf-relay cisco-rtp
 ip qos dscp cs5 media
 ip qos dscp cs5 signaling
 no vad
```

FRF.5 over G.SHDSL Example

The following output is from a Cisco 1721 router. This example shows how to create an FRF.5 one-to-one connection using the the **connect** command with the **network-interworking** keyword.

```
frame-relay switching
!
interface ATM0
 no ip address
 no atm ilmi-keepalive
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
interface ATM0.1 point-to-point
 pvc 0/33
  encapsulation aal5mux frame-relay
!
interface Serial0
 no ip address
 encapsulation frame-relay IETF
 clockrate 2000000
 frame-relay interface-dlci 100 switched
 frame-relay intf-type dce
!
connect frf5 Serial0 100 ATM0 0/33 network-interworking
!
```

The following example shows how to create an FRF.5 many-to-one connection.

```
vc-group groupA
 Serial0 100 100
 Serial0 200 200
 Serial0 300 300
 Serial0 400 400
!
interface ATM0
 no ip address
 no atm ilmi-keepalive
 pvc 0/33
  encapsulation aal5mux frame-relay
```

```
!
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
connect frf5-v vc-group GroupA ATM0 0/33
```

Note For FRF.5, you may need to match the maximum transmission unit (MTU) between the ATM and Frame Relay networks for large size packets.

FRF.8 over G.SHDSL Example

The following output is from a Cisco 1721 router. This example shows how to create an FRF.8 connection using the the **connect** command with the **service-interworking** keyword.

```
frame-relay switching
!
interface ATM0
 no ip address
 no atm ilmi-keepalive
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
interface ATM0.1 point-to-point
 pvc 0/33
  encapsulation aal5mux fr-atm-srv
!
interface Serial0
 no ip address
 encapsulation frame-relay IETF
 clockrate 2000000
 frame-relay interface-dlci 100 switched
 frame-relay intf-type dce
!
ip classless
no ip http server
!
connect frf8 Serial0 100 ATM0 0/33 service-interworking
```

Note For FRF.8, you may need to match the maximum transmission unit (MTU) between the ATM and Frame Relay networks for large size packets.

MLP Bundling Example

The following output examples show how MLP DSL links can be bundled using a multilink interface. The configurations were created using devices in a specific laboratory environment. All of the devices started with a cleared (default) configuration. If you are working in a live network situation, make sure that you understand the potential impact of all commands before using them (refer to the command references for Cisco IOS Release 12.2).

Note Before configuring MLP bundling, ensure that IP CEF is turned on for QoS.

The following example was configured on a Cisco 2600 router equipped with two xDSL WICs.

```
ip subnet-zero
ip cef
!
no ip domain lookup
!
class-map match-all VOICE
 match access-group 100
!
policy-map green
 class VOICE
  priority 100
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.0
!
interface Multilink1
 ip unnumbered Loopback0
 load-interval 30
 service-policy output green
  ip nat outside
 no cdp enable
 ppp multilink
 ppp multilink fragment-delay 6
 ppp multilink interleave
 multilink-group 1
!
interface ATM0/0
 no ip address
 load-interval 30
 no atm ilmi-keepalive
 dsl operating-mode auto
!
interface ATM0/0.1 point-to-point
 pvc 203/202
  vbr-rt 640 640
  tx-ring-limit 3
  protocol ppp Virtual-Template1
!
interface FastEthernet0/0

ip address 10.3.202.48 255.0.0.0
 load-interval 30
 duplex auto
 speed auto
 no cdp enable
!
interface ATM0/1
 no ip address
 load-interval 30
 no atm ilmi-keepalive
 dsl operating-mode auto
!
interface ATM0/1.1 point-to-point
 pvc 5/201
  vbr-rt 640 640
  tx-ring-limit 3
  protocol ppp Virtual-Template1
!
interface FastEthernet0/1
 description ip address 10.6.6.6 255.0.0.0
 mac-address 0000.0000.0003
 ip address 10.1.1.30 255.255.255.0
```

```
 load-interval 30
 duplex auto
 speed auto
 no cdp enable
!
interface Virtual-Template1
 no ip address
 load-interval 30
 ppp authentication chap pap
 ppp multilink
 ppp multilink multiclass
 multilink-group 1
!
ip classless
ip route 10.1.1.0 255.255.255.0 2.2.2.3
ip route 10.1.1.1 255.255.255.255 2.2.2.3
ip route 192.168.254.254 255.255.255.255 1.3.0.1
no ip http server
ip pim bidir-enable
!
access-list 100 permit udp any any precedence critical
access-list 100 permit tcp any any eq 1720

access-list 100 permit tcp any eq 1720 any
no cdp run
!
snmp-server manager
call rsvp-sync
!
voice-port 1/1/0
!
voice-port 1/1/1
!
mgcp profile default
!
dial-peer cor custom
!
dial-peer voice 101 voip
 incoming called-number 10.....
 destination-pattern 200....
 session target ipv4:2.2.2.3
 ip qos dscp cs5 media
 ip qos dscp cs5 signaling
 no vad
!
dial-peer voice 200 pots
 destination-pattern 100....
 port 1/1/0
 prefix 200
!
alias exec c conf t
alias exec s sh run
!
line con 0
 exec-timeout 0 0
 privilege level 15
line aux 0
line vty 0 4
 login
line vty 5 15
 login
```

The following example was configured on a Cisco 3660 or Cisco 7206 router:

```
ip subnet-zero
ip cef
!
no ip domain lookup
!
class-map match-all VOICE
 match access-group 100
!
policy-map PURPLE
 class VOICE
  priority 100
!
voice call carrier capacity active
!
fax interface-type fax-mail

mta receive maximum-recipients 0
!
interface Loopback0
 ip address 10.2.2.3 255.255.255.0
!
interface Multilink1
 ip unnumbered Loopback0
 load-interval 30
 service-policy output PURPLE
 no cdp enable
 ppp multilink
 ppp multilink fragment-delay 6
 ppp multilink interleave
 multilink-group 1
!
interface FastEthernet0/0
 mac-address 0000.0000.0004
 ip address 10.3.202.89 255.0.0.0
 load-interval 30
 duplex auto
 speed auto
 no cdp enable
!
interface FastEthernet0/1
 mac-address 0000.0000.0004
 ip address 10.1.1.20 255.255.255.0
 load-interval 30
 no keepalive
 duplex auto
 speed auto
 no cdp enable
!
interface ATM2/0
 no ip address
 load-interval 30
 atm clock INTERNAL
 no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
 pvc 203/202
  vbr-rt 640 640
  tx-ring-limit 3
  protocol ppp Virtual-Template1
!
interface ATM2/0.2 point-to-point
 pvc 5/201
  vbr-rt 640 640
  tx-ring-limit 3
```

```
  protocol ppp Virtual-Template1
!
interface Virtual-Template1
 no ip address
 load-interval 30
 ppp authentication chap pap
 ppp multilink
 ppp multilink multiclass
 multilink-group 1
!
ip classless
ip route 10.1.1.0 255.255.255.0 2.2.2.2
ip route 10.1.1.1 255.255.255.255 2.2.2.2
ip route 192.168.254.254 255.255.255.255 1.3.0.1
ip http server
ip pim bidir-enable
!
access-list 100 permit udp any any precedence critical
access-list 100 permit tcp any any eq 1720
access-list 100 permit tcp any eq 1720 any
no cdp run
!
call rsvp-sync
!
voice-port 4/1/0
!
voice-port 4/1/1
!
mgcp profile default
!
dial-peer cor custom
dial-peer voice 101 voip
 incoming called-number 200....
 destination-pattern 10.....
 session target ipv4:2.2.2.2
 ip qos dscp cs5 media
 ip qos dscp cs5 signaling
 no vad
!
dial-peer voice 200 pots
 destination-pattern 200....
 port 4/1/0
 prefix 200
!
alias exec c conf t
alias exec s sh run
!
line con 0
 exec-timeout 0 0
 privilege level 15
 line aux 0
 line vty 0 4
 password green
 login
```

Tx Ring-Limit Tuning over ADSL Example

The following output is from a Cisco 1751 router. The tx ring limit is configured on an ATM PVC interface.

```
class-map match-all VOIP
 match ip dscp 32
```

```
class-map CRITICAL
 match access-group 100
!
policy-map 1751_ADSL
 class CRITICAL
  priority 48
 class VOIP
  bandwidth 64
  set ip precedence 6
!
interface Loopback1
ip address 10.0.0.10 255.255.255.252
!
interface ATM0/0
 no ip address
 no atm ilmi-keepalive
!
interface ATM0/0.1
 pvc 0/33
  vbr-rt 320 320 30
  tx-ring-limit 3
  protocol ppp Virtual-Template1
!
interface Virtual-Template1
 bandwidth 320
 ip unnumbered Loopback1
 ip mroute-cache
 service-policy output 1751_ADSL
 ppp multilink
 ppp multilink fragment-delay 4
 ppp multilink interleave
```

The following output is from a Cisco 2600 router that is configured for tx ring-limit tuning:

```
voice-card 1
 dspfarm
!
ip subnet-zero
!
ip cef
!
class-map match-all VOICE-CLASS
 match access-group 100
!
policy-map SERVICE-PACK-640
 class VOICE-CLASS
  priority 160
!
controller T1 1/0
 framing esf
 linecode b8zs
 ds0-group 0 timeslots 1-24 type e&m-wink-start
!
controller T1 1/1
 framing sf
 linecode ami
!
interface FastEthernet0/0
 ip address 10.3.214.50 255.255.0.0
 duplex auto
 speed auto
!
interface ATM0/1
 no ip address
```

```
 load-interval 30
 atm vc-per-vp 256
 no atm ilmi-keepalive
 atm voice aal2 aggregate-svc upspeed-number 0
 dsl equipment-type CPE
 dsl operating-mode GSHDSL symmetric annex A
 dsl linerate AUTO
!
interface ATM0/1.1 point-to-point
 ip address 192.168.1.2 255.255.255.0
 pvc 11/201
  protocol ip 192.168.1.1 broadcast
  vbr-nrt 640 640
  tx-ring-limit 3
  oam-pvc manage
  service-policy output SERVICE-PACK-640
!
interface FastEthernet0/1
 ip address 10.10.11.1 255.255.255.0
 load-interval 30
 duplex auto
 speed auto
!
ip classless
ip route 10.10.11.254 255.255.255.255 192.168.1.1
ip route 192.168.254.254 255.255.255.255 1.3.0.1
ip http server
ip pim bidir-enable
!
ip director cache time 60
access-list 100 permit udp any any precedence critical
!
snmp-server manager
call rsvp-sync
!
voice-port 1/0:0
!
mgcp profile default
!
dial-peer cor custom
!
dial-peer voice 1 pots
 destination-pattern 7...
!
dial-peer voice 2 voip
 pattern 8...
 session target ipv4:192.168.1.1
 ip qos dscp cs5 media
 ip qos dscp cs5 signaling
 no vad
!
alias exec s sh run
alias exec c conf t
!
line con 0
 exec-timeout 0 0
 privilege level 15
line aux 0
line vty 0 4
 login
line vty 5 15
 login
```

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.

New

- **clock rate (interface ATM)**
- **ppp multilink multiclass**

Modified

- **connect (FRF.5)**
- **connect (FRF.8)**
- **de-bit**
- **tx-ring-limit**

clock rate (interface ATM)

To configure the clock rate between a wide-area network interface card (WIC) and the serial communication controllers (SCCs) that are used by the WIC, use the **clock rate** command in interface ATM mode. To disable the clock rate setting, use the **no** form of this command.

clock rate [**aal2** | **aal5**] *clock-rate-value*

no clock rate [**aal2** | **aal5**] *clock-rate-value*

Syntax Description

aal2	(Optional) AAL2.
aal5	(Optional) ATM adaptation layer 5 (AAL5).
clock-rate-value	The clock rate value can be changed as follows: • **aal2**—For Cisco 1700 series routers, the minimum value for ADSL and G.SHDSL is 4 Mbps. The default value for ADSL and G.SHDSL is 8 Mbps. For Cisco 2600 and 3600 series routers, the minimum value for ADSL and G.SHDSL is 1 Mbps. The maximum value is 7 Mbps for mainboard slots and 5.3 Mbps for network modules. The default value for ADSL and G.SHDSL is 2.6 Mbps for both mainboard slots and network modules. To make full use of the 2.3 Mbps bandwidth for VoATM non-switched trunk calls on G.SHDSL, you can change the 1 Mbps default value on Cisco 2600 series and Cisco 3600 series routers and configure the AAL2 clock rate as 2.6 Mbps. It is recommended, however, that you keep the ADSL SCC clock rate for AAL2 at the default value of 1 Mbps because the upstream of ADSL cannot exceed 1 Mbps. **Note** You should change the AAL2 default value on Cisco 2600 and Cisco 3600 series routers only if you are using G.SHDSL for VoATM non-switched trunk calls using a NM-HDV. All other times, the default for AAL2 should remain at 1 Mbps for ADSL and G.SHDSL. • **aal5**—For Cisco 1700 series routers, the minimum value for ADSL and G.SHDSL is 4 Mbps. The default value for ADSL and G.SHDSL is 8 Mbps. For Cisco 2600 and 3600 series routers, the minimum value for ADSL and G.SHDSL is 1 Mbps. The maximum value is 7 Mbps for mainboard slots and 5.3 Mbps for network modules. The default value for ADSL and G.SHDSL is 2.6 Mbps for both mainboard slots and network modules. **Note** If you configure a clock rate that exceeds the maximum limit, the configuration will fail. (See "Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco Series."

Command Modes

Interface ATM configuration

Command History

Release	Modification
12.2(8)YN	This command was introduced on the Cisco 1700, Cisco 2600, and Cisco 3600 series.

Usage Guidelines

The communication between DSL WICs and a host in a router occurs through a device called the SCC. If a host wants to forward data or send any control traffic to a DSL WIC, it uses SCCs. In the same way, if a DSL WIC wants to forward incoming data from a line to the host, it also uses SCCs. Each DSL WIC installed in the router uses two SCCs. One SCC (SCC-A) is used for AAL5 data traffic, and the other SCC (SCC-B) is used for AAL2 and control traffic. The speed at which the SCC transfers data between a host and a WIC depends on the clock rate with which it has been configured. You can configure this clock rate on the basis of the DSL line rate. Even though the DSL upstream and downstream line rate may vary, the clock rate between the SCC and the DSL WIC is the same for both the transmitting and receiving direction. That is, the communication between the SCC and the DSL WIC is synchronous. Therefore, you need to configure only one clock rate for an SCC that will be used for both transmitting and receiving between an SCC and a DSL WIC.

It is always recommended that you configure the SCC clock rate slightly higher than the DSL line rate to accommodate overhead between the SCC and DSL WIC. For an asynchronous DSL WIC (for example, ADSL), the SCC clock rate depends on either the downstream or the upstream line rate, whichever is the maximum rate. For a synchronous DSL WIC (for example, G.SHDSL), the bandwidth for upstream and downstream is the same. Therefore, the SCC clock rate configuration can be based on either the upstream or the downstream line rate.

Because the maximum line rate for G.SHDSL is 2.312 Mbps, the default SCC clock rate of 2.6 Mbps for AAL5 and 1 Mbps for AAL2 should be sufficient. However, for ADSL, the clock rate may need to be configured on the basis of the current line rate. If AAL2 is used for voice traffic, the AAL2 SCC must be configured to the appropriate clock rate: 1 Mbps for ADSL and 2.6 Mbps for G.SHDSL.

The maximum data rate between an SCC and a DSL WIC depends primarily on the maximum clock rate that the SCC can support. For example, on the Cisco 2600 mainboard, which supports two DSL WICs, the total SCC clock rate that can be configured for both WICs is 8 Mbps. Therefore, if only one DSL WIC is present on the mainboard, AAL5 and AAL2 clock rates can be configured to 7 Mbps and 1 Mbps, respectively. If two DSL WICs are supported on the mainboard, the total of 8 Mbps should be distributed among the four SCCs.

Network module SCCs also pose similar limitations. That is, on the Cisco 2600, the total clock rate for all four SCCs is 8 Mbps. The maximum AAL5 clock rate that may be configured on a network module is 5.3 Mbps. On the Cisco 1700, the maximum configurable SCC clock rate for both AAL5 and AAL2 is 8 Mbps.

If the clock rate is unconfigured, the SCC is reset to the default values.

The clock rate can be configured independently for each SCC. To verify the clock rate setting, use the **show running-config** command.

Examples

The following example for a Cisco 2600 series or Cisco 3600 series router shows that the clock rate is set to 2 Mbps for AAL5 and to 1.3 Mbps for AAL2:

```
Router (config)# interface atm1/0
Router (config-if)# no ip address
```

```
Router (config-if)# no atm ilmi-keepalive
Router (config-if)# pvc 6/65
Router (config-if)# clock rate aal5 2000000
Router (config-if)# clock rate aal2 1300000
Router (config-if)# vbr-nrt 640 640 128
Router (config-if)# tx-ring-limit 3
```

connect (FRF.5)

To configure an FRF.5 one-to-one or many-to-one connection between two Frame Relay end users over an intermediate ATM network, use the **connect** command in global configuration mode. To remove a connection, use the **no** form of this command.

connect *connection-name* {**vc-group** *group-name* | *FR-interface FR-DLCI*} *ATM-interface ATM-VPI/VCI* **network-interworking**

no connect *connection-name* {**vc-group** *group-name* | *FR-interface FR-DLCI*} *ATM-interface ATM-VPI/VCI* **network-interworking**

Syntax Description

connection-name	Connection name. Enter as a 15-character maximum string.
vc-group *group-name*	VC group name for a many-to-one FRF.5 connection. Enter as an 11-character maximum string. (If the **vc-group** keyword is specified, the interworking type is always network-interworking and does not need to be set as such.)
FR-interface	Frame Relay interface type and number, for example, **serial1/0**.
FR-DLCI	Frame Relay data-link connection identifier (DLCI) in the range from 16 to 1007.
ATM-interface	ATM interface type and number, for example, **atm1/0**.
ATM-VPI/VCI	ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0.
network-interworking	FRF.5 network interworking connection. This keyword is not valid if the **vc-group** keyword is specified. (If the **vc-group** keyword is specified, the interworking type is always network-interworking and does not need to be set as such.)

Defaults

No default behavior or values

Command Modes

Global configuration

Command History

Release	Modification
12.1(2)T	This command was introduced.
12.2(8)YN	This command was implemented on the Cisco 1700 series.

Usage Guidelines

Use the **connect** command to connect a group of Frame Relay DLCIs to an ATM PVC.

To connect to the Frame Relay DLCI that has been configured on the interface, the Frame Relay DLCI must be configured on the interface using the **frame-relay interface-dlci switched** command.

To disconnect the FRF.5 interworking connection, use the **shutdown connect** subcommand.

Examples

The following example shows how to create an FRF.5 one-to-one connection (not using the **vc-group** keyword):

```
Router(config)# interface serial0/0
Router(config-if)# frame-relay interface-dlci 100 switched
Router(config-if)# interface atm1/0
Router(config-if)# pvc 0/32
Router(config-if-atm-vc)# encapsulation aal5mux frame-relay
Router (config-if-atm-vc)# exit
Router (config-if)# exit
Router(config)# connect frf5 serial0/0 100 atm1/0 0/32 network-interworking
Router(config-frf5)# clp-bit 1
Router(config-frf5)# de-bit map-clp
```

The following example shows how to create an FRF.5 many-to-one connection (using the **vc-group** keyword):

```
Router(config)# interface serial1/0
Router(config-if)# frame-relay interface-dlci 100 switched
Router (config-if)# exit
Router(config)# vc-group friends
Router(config-vc-group)# serial1/0 16 16
Router(config-vc-group)# serial1/0 17 17
Router(config-vc-group)# serial1/0 18 18
Router(config-vc-group)# serial1/0 19 19
Router (config-vc-group)# exit
Router(config)# interface atm1/0
Router(config-if)# pvc 0/32
Router(config-if-atm-vc)# encapsulation aal5mux frame-relay
Router (config-if-atm-vc)# exit
Router (config-if)# exit
Router(config)# connect frf5-v vc-group friends atm1/0 0/32
Router(config-frf5)# de-bit map-clp
```

Related Commands

Command	Description
clp-bit	Sets the ATM CLP field in the ATM cell header.
de-bit	Sets the Frame Relay DE bit field in the Frame Relay cell header for FRF.5 and FRF.8 service interworking.
encapsulation aal5	Configures the AAL and encapsulation type for an ATM PVC, SVC, VC class, or VC bundle.
frame-relay interface-dlci switched	Indicates that a Frame Relay DLCI is switched.
pvc	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, or enters interface-AMT-VC configuration mode.
vc-group	Assigns multiple Frame Relay DLCIs to a VC group.

connect (FRF.8)

To configure an FRF.8 one-to-one mapping between a Frame Relay data-link connection identifier (DLCI) and an ATM permanent virtual circuit (PVC), use the **connect** command in global configuration mode. To remove a connection, use the **no** form of this command.

connect *connection-name FR-interface FR-DLCI ATM-interface ATM-VPI/VCI* **service-interworking**

no connect *connection-name FR-interface FR-DLCI ATM-interface ATM-VPI/VCI* **service-interworking**

Syntax Description

connection-name	Connection name. Enter as a 15-character maximum string.
FR-interface	Frame Relay interface type and number, for example, **serial1/0**.
FR-DLCI	Frame Relay DLCI in the range 16 to 1007.
ATM-interface	ATM interface type and number, for example, **atm1/0**.
ATM-VPI/VCI	ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0.
service-interworking	FRF.8 service interworking.

Defaults

No default behavior or values

Command Modes

Global configuration

Command History

Release	Modification
12.1(2)T	This command was introduced.
12.2(8)YN	This command was implemented on the Cisco 1700 series.

Usage Guidelines

Use the **connect** command to connect a Frame Relay DLCI to an ATM PVC.

To disconnect the FRF.8 interworking connection, use the **shutdown connect** subcommand.

Examples

The following example shows how to create an FRF.8 connection:

```
Router(config)# interface serial0/0
Router(config-if)# frame-relay interface-dlci 100 switched
Router(config-if)# interface atm1/0
Router(config-if)# pvc 0/32
Router(config-if-atm-vc)# encapsulation aal5mux fr-atm-srv
Router (config-if-atm-vc)# exit
Router (config-if)# exit
Router(config)# connect service-1 Serial0/0 100 ATM1/0 0/32 service-interworking
Router(config-frf8)# efci-bit map-fecn
```

Related Commands

Command	Description
clp-bit	Sets the ATM CLP field in the ATM cell header.
de-bit	Sets the Frame Relay DE bit field in the Frame Relay cell header for FRF.5 and FRF.8 service interworking.
efci-bit	Sets the EFCI bit field in the ATM cell header for FRF.8 service interworking.
encapsulation aal5	Configures the AAL and encapsulation type for an ATM PVC, SVC, VC class, or VC bundle.
pvc	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, or enters interface-AMT-VC configuration mode.

de-bit

To set Frame Relay discard eligible (DE) bit mapping for FRF.5 and FRF.8 network interworking, use the **de-bit** command in FRF.5 connect or FRF.8 connect configuration mode. To disable or reset Frame Relay DE bit mapping, use the **no** form of this command.

de-bit {**0** | **1** | **map-clp**}

no de-bit {**0** | **1** | **map-clp**}

Syntax Description

0	Always sets the DE field in the Frame Relay header to 0. This keyword may be used only for FRF.8.
1	Always sets the DE field in the Frame Relay header to 1. This keyword may be used only for FRF.8.
map-clp	DE field in the Frame Relay header is set to 1 if one or more cells that belong to a frame have their cell loss priority (CLP) field set. The default is **map-clp**. This keyword may be used for FRF.5 or FRF.8. **Note** **map-clp** is the only keyword available for FRF.5.

Defaults

map-clp

Command Modes

FRF.5 connect submode
FRF.8 connect submode

Command History

Release	Modification
12.1(2)T	This command was introduced.
12.2(8)YN	This command was implemented on the Cisco 1700 series.

Usage Guidelines

In the default state, the DE bit in the Frame Relay header is set to 1 when one or more ATM cells that belong to a frame have their cell loss priority (CLP) field set to 1 or when the DE field of the Frame Relay service specific convergence sublayer (FR-SSCS) protocol data unit (PDU) is set to 1.

When the **no de-bit** command and **map-clp** keyword is entered, the FR-SSCS PDU DE field is copied unchanged to the Q.922 core frame DE field, independent of CLP indications received at the ATM layer.

Examples

The following example creates a connection that connects the virtual circuit (VC) group named “friends” to ATM PVC 0/32 and configures FR DE field mapping to match the ATM CLP field:

```
Router(config)# vc-group friends
Router(config-vc-group)# serial1/0 16 16
Router(config-vc-group)# serial1/0 17 17
Router(config-vc-group)# serial1/0 18 18
Router(config-vc-group)# serial1/0 19 19
Router(config)# interface atm3/0
```

```
Router(config-if)# pvc 0/32
Router(config-if-atm-vc)# encapsulation aal5mux frame-relay
Router (config-if-atm-vc)# exit
Router (config-if)# exit
Router(config)# connect vc-group friends atm3/0 0/32
Router(config-frf5)# de-bit map-clp
```

Related Commands

Command	Description
clp-bit	Sets the ATM CLP field in the ATM cell header.
connect (FRF.5)	Configures an FRF.5 one-to-one connection or one-to-many connection between two Frame Relay end users over an intermediate ATM network.
connect (FRF.8)	Configures an FRF.8 one-to-one mapping between a Frame Relay DLCI and an ATM PVC.
vc-group	Assigns multiple Frame Relay DLCIs to a VC group.

ppp multilink multiclass

To enable a multiclass multilink, use the **ppp multilink multiclass** command in interface configuration mode. To disable the multiclass multilink, use the **no** form of this command.

ppp multilink multiclass

no ppp multilink multiclass

Syntax Description

This command has no arguments or keywords.

Defaults

A multiclass multilink is not enabled.

Command Modes

Interface configuration

Command History

Release	Modification
12.2(8)YN	This command was introduced on the Cisco 1700, Cisco 2600, and Cisco 3600 series.

Usage Guidelines

This command must be entered on member links, not on the bundle interface itself. In the case of Point-to-Point Protocol over ATM (PPPoA) or Point-to-Point Protocol over Frame Relay (PPPoFR), the command is entered on the virtual template.

If this command is configured (and assuming that the peer also supports and is configured for multiclass interleaving), interleaved packets are assigned sequence numbers so that they are kept in order at the receiving end. Without this command, interleaved packets are sent without multilink headers so that they are subject to reordering when sent over parallel links.

Examples

The following example shows that interleaving is configured on the bundle interface while multiclass is configured on the member links (in this case, any Virtual-Access interfaces that are cloned from the Virtual-Template):

```
Router (config)# interface Multilink1
Router (config-if)# ip address 10.0.0.50 255.255.255.240
Router (config-if)# fair-queue
Router (config-if)# ppp multilink
Router (config-if)# ppp multilink fragment-delay 10
Router (config-if)# ppp multilink interleave
Router (config-if)# multilink-group 2
!
Router (config)# interface Virtual-Template1
Router (config-if)# no ip address
Router (config-if)# ppp multilink
Router (config-if)# ppp multilink multiclass
Router (config-if)# multilink-group 2
```

Related Commands

Command	Description
ppp multilink	Enables MLP on an interface and, optionally, enables BACP and BAP for dynamic bandwidth allocation.
ppp multilink fragment-delay	Specifies a maximum size in units of time for packet fragments on a MLP bundle.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on a MLP bundle.

tx-ring-limit

To limit the number of packets that can be used on a transmission (tx) ring on a DSL wide-area network interface card (WIC), use the **tx-ring-limit** command in ATM VC configuration mode. To not limit the number of packets that can be used on a transmission ring on a DSL WIC, use the **no** form of this command.

tx-ring-limit *ring-limit*

no tx-ring-limit *ring-limit*

Syntax Description

ring-limit	Maximum number of allowable packets that can be placed on the transmission ring. The default value is 60. On Cisco 1700 series routers, possible values are 2 through 60. On Cisco 2600 and 3600 series routers, possible values are 3 through 60.

Defaults

The default value of the *ring-limit* argument is 60.

Command Modes

ATM VC configuration

Command History

Release	Modification
12.0(7)XE1	This command was introduced.
12.0(9)S	This command was integrated into Cisco IOS Release 12.0(9)S.
12.1(5)T	This command was integrated into Cisco IOS Release 12.1(5)T.
12.2(2)XK	Support was added for ADSL, and a tx ring setting of 3 was added for latency-critical traffic for ADSL, on Cisco 2600 and Cisco 3600 routers.
12.2(4)XL	Support was added for G.SHDSL.
12.2(8)YN	Values and default values were added for the Cisco 1700, Cisco 2600, and Cisco 3600 series. This command was implemented on the Cisco 1700 in this release.

Examples

The following example configures the transmission ring limit to three packets on an ATM permanent virtual circuit (PVC) subinterface:

```
Router(config)# interface atm1/0.1 point-to-point
Router(config-subif)# pvc 2/200
Router(config-if-atm-vc)# tx-ring-limit 3
```

Related Commands

Command	Description
show atm vc	Displays all ATM PVCs and traffic information.