



Enhanced Voice and QoS for ADSL and G.SHDSL

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.

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). When the ADSL or G.SHDSL WAN interface cards (WICs) are installed, they support the integration of voice and data over the same ADSL or G.SHDSL circuit using Voice over IP (VoIP).

Feature History for Enhanced Voice and QoS for ADSL and G.SHDSL

Feature History	
Release	Modification
12.2(2)XQ	This feature was introduced. The Cisco 1720 did not support voice.
12.2(2)XK	Support was added for Cisco 2610-2651, Cisco 3620, Cisco 3640, and Cisco 3660.
12.2(4)XL	Support was added for Cisco 1720, Cisco 1750, Cisco 1751, and Cisco 1760.
12.2(8)YN	Enhanced voice and QoS features were added for Cisco 1720, Cisco 1721, Cisco 1751, Cisco 1760, Cisco 2610XM-2651XM, Cisco 3640, Cisco 3640A, and Cisco 3660.
12.2(13)T	Enhanced voice and QoS features that were introduced in 12.2(2)XQ, 12.2(2)XK, and 12.2(4)XL were integrated into Cisco IOS Release 12.2(13)T.
12.3(2)T	Enhanced voice and QoS features that were introduced in 12.2(8)YN were integrated into Cisco IOS Release 12.3(2)T.

Finding Support Information for Platforms and Cisco IOS Software Images

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



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Prerequisites for Enhanced Voice and QoS for ADSL and G.SHDSL

To configure the voice and QoS features, you must first install and configure the ADSL WIC or G.SHDSL WIC on your platform. 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
- 1-Port G.SHDSL WAN Interface Card for Cisco 2600 Series and 3600 Series Routers
- ADSL WAN Interface Card for the Cisco 2600/3600/3700 Series
- G.SHDSL WAN Interface Card for the Cisco 2600/3600/3700 Series

For analog voice interface support, you must install the appropriate voice interface card (VIC).

Restrictions for Enhanced Voice and QoS for ADSL and G.SHDSL

- 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.

Information About Enhanced Voice and QoS for ADSL and G.SHDSL

To configure the voice and QoS features, you must understand the following concepts:

- [Classification and Marking, page 5](#)
- [Queueing and Scheduling, page 7](#)
- [Congestion Avoidance, page 8](#)
- [Policing and Traffic Shaping, page 8](#)

- [Link Efficiency](#), page 9
- [Other \(IP QoS\)](#), page 12
- [Additional Supported Features](#), page 12
- [Benefits of QoS](#), page 16

Table 1 lists the voice and QoS feature set, the specific feature, and the release in which the features are available.

Table 1 *Voice and QoS Feature Set and the Available Cisco IOS Release*

Voice/QoS Feature Set	Specific Feature	Release
Classification and Marking	ATM CLP Bit Marking	12.2(8)YN
	Class-Based Packet Marking with Differentiated Services	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	Committed Access Rate (CAR)	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	Dial-Peer DSCP and IP Precedence Marking	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	Local Policy Routing	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
	Policy-Based Routing	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Queueing and Scheduling	Class-Based Weighted Fair Queueing (CBWFQ)	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
	Per-VC Queueing	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
Congestion Avoidance	Class-Based WRED with DSCP (Egress)	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
	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
Policing and Traffic Shaping	ATM Traffic Shaping	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
	Traffic Policing	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

Table 1 ***Voice and QoS Feature Set and the Available Cisco IOS Release (continued)***

Voice/QoS Feature Set	Specific Feature	Release
Link Efficiency	cRTP over an ATM Link with PPP Encapsulation	12.2(8)YN
	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
	MLP Bundling	12.2(8)YN
	PPPoE MTU Adjustment	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
Other IP QoS	Access Control Lists	12.2(2)XK, 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

Table 1 *Voice and QoS Feature Set and the Available Cisco IOS Release (continued)*

Voice/QoS Feature Set	Specific Feature	Release
Additional Voice/QoS	Analog Voice Interface Support	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
	Concurrent VoIP and VoATM	12.2(2)XK, 12.2(4)XL, and 12.2(8)YN
	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
	Multiple PVC Support	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	OAM	12.2(2)XQ, 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 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
	Session Initiation Protocol (SIP)	12.2(8)YN
	Survivable Remote Site Telephony (SRST)	12.2(8)YN
	VoATM over AAL2 ¹	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	VoATM over AAL5 ¹	12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T
	VoIP over AAL5	12.2(2)XQ, 12.2(2)XK, 12.2(4)XL, 12.2(8)YN, and 12.2(13)T

1. Not supported on the Cisco 1700 series.

Classification and Marking

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

- [ATM CLP Bit Marking, page 6](#)
- [Class-Based Packet Marking with Differentiated Services, page 6](#)
- [Committed Access Rate, page 6](#)

- [Dial-Peer DSCP and IP Precedence Marking, page 6](#)
- [Local Policy Routing, page 6](#)
- [Network-Based Application Recognition, page 7](#)
- [Policy-Based Routing, page 7](#)

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 [“ATM CLP Bit Marking over G.SHDSL Example”](#) section on [page 57](#). For more information about ATM cell bit marking, refer to [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 [“Quality of Service Overview”](#) chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#).

Committed Access Rate

For information about committed access rate (CAR), refer to the [“Quality of Service Overview”](#) chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#).

Dial-Peer DSCP and IP Precedence Marking

For information about dial-peer differentiated services code points (DSCPs) and IP precedence marking, refer to the [“Quality of Service for Voice over IP”](#) chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#).

Local Policy Routing

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

- “Configuring IP Routing Protocol—Independent Features” chapter in the [Cisco IOS IP Configuration Guide](#)
- “Configuring IP Routing Protocols” chapter 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
- Using Content Networking to Provide Quality of Service
- “Configuring Network-Based Application Recognition” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*

Policy-Based Routing

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

- “Quality of Service Overview” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*

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, page 7](#)
- [Low Latency Queueing, page 7](#)
- [Per-VC Queueing, page 7](#)

Class-Based Weighted Fair Queueing

For information about class-based weighted fair queueing (CBWFQ), refer to “Quality of Service Overview” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Low Latency Queueing

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

- “Congestion Management Overview” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*



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 11](#).

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 Queueing 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 \(Egress\)](#), page 8
- [Resource Reservation Protocol](#), page 8
- [Weighted Random Early Detection](#), page 8

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:

- “Quality of Service Overview” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#)
- [Cisco IOS Quality of Service Solutions Command Reference](#)
- [DiffServ Compliant Weighted Random Early Detection](#)

Resource Reservation Protocol

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

- “Configuring RSVP” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#)
- “Configuring RSVP Support for LLQ” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#)
- “Configuring RSVP Support for Frame Relay” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#)
- “Configuring RSVP-ATM QoS Interworking” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#)

Weighted Random Early Detection

For information about Weighted Random Early Detection (WRED), refer to the “Configuring Weighted Random Early Detection” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#).

Policing and Traffic Shaping

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

- [ATM Traffic Shaping](#), page 9
- [Class-Based Policing](#), page 9
- [Traffic Policing](#), page 9

- [VC Shaping for Variable Bit Rate-Nonreal Time, page 9](#)

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
- “Policing and Shaping Overview” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*

Class-Based Policing

For information about traffic classes and traffic policies, refer to the “Configuring Traffic Policing” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Traffic Policing

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

- “Configuring Traffic Policing” chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*
- *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 *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, page 9](#)
- [Link Fragmentation and Interleaving, page 10](#)
- [MLP Bundling, page 10](#)
- [PPPoE MTU Adjustment, page 11](#)
- [Tunable Transmission Ring, page 11](#)
- [VC Bundling, page 11](#)

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. RTP header compression 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. The **ip tcp header-compression** 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 that use 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 the cRTP over an ATM Link with PPP Encapsulation feature, see the [Configuring cRTP over an ATM Link with ATM Encapsulation, page 25](#).

Link Fragmentation and Interleaving

For information about the Link Fragmentation and Interleaving (LFI) feature, refer to the “Configuring Link Fragmentation and Interleaving for Frame Relay and ATM Virtual Circuits” chapter in the Cisco IOS Quality of Service Solutions Configuration Guide.

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.
- The virtual template (VT) should be used (instead of the dialer interface) when configuring either authentication or dynamic address assignment for MLP with LFI.

To enable MLP bundling, see the section “[Configuring MLP Bundling, page 46](#).”

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 *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 1 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 information about virtual circuit (VC) bundling, refer to *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, page 12](#)
- [IP QoS Map to ATM Class of Service, page 12](#)

Access Control Lists

For information about access control lists, refer to the “Configuring IP Services” chapter in the [Cisco IOS IP Configuration Guide](#).

IP QoS Map to ATM Class of Service

For information about IP QoS map to ATM class of service (CoS), refer to the “Configuring IP to ATM Class of Service” chapter in the [Cisco IOS Quality of Service Solutions Configuration Guide](#).

Additional Supported Features

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

- [Analog Voice Interface Support, page 13](#) (requires an appropriate VIC)
- [Clock Rate for AAL5 and AAL2, page 13](#)
- [Concurrent VoIP and VoATM, page 14](#)
- [F5 OAM CC Segment Functionality, page 14](#)
- [FRF.5 and FRF.8, page 14](#)
- [H.323 and Media Gateway Control Protocol, page 14](#)
- [ILMI, page 14](#)
- [Multiple PVC Support, page 14](#)
- [OAM, page 15](#)
- [PPPoE Client, page 15](#)
- [PPPoE over ATM, page 15](#)
- [RFC 1483 Bridging, page 15](#)
- [RFC 1483 Routing, page 15](#)
- [Session Initiation Protocol, page 16](#)
- [Survivable Remote Site Telephony, page 16](#)
- [VoATM over AAL2, page 16](#)
- [VoATM over AAL5](#)
- [VoIP over AAL5, page 16](#)

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 *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 ATM adaptation layer 5 (AAL5) data traffic, and the other SCC (SCC-B) is used for ATM adaptation layer 2 (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 [Configuring the Clock Rate for ADSL and G.SHDSL WICs, page 20](#).

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 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 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 [Configuring FRF.5 One-To-One Connections, page 33](#) and [Configuring FRF.8, page 41](#).

H.323 and Media Gateway Control Protocol

For information about H.323 and Media Gateway Control Protocol (MGCP) testing, refer to *Cisco IOS H.323 Configuration Guide* in the [Cisco IOS Voice Configuration Library](#).

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 “Configuring ILMI” chapter 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:

- “Wide-Area Networking Overview” chapter in [Cisco IOS Wide-Area Networking Configuration Guide](#)
- “Configuring ATM” chapter in the [Cisco IOS Asynchronous Transfer Mode Configuration Guide](#)

Refer to the following documents for caveat information for multiple PVCs by platform 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 by platform 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 *Release Notes for the Cisco 1700 Series Routers for Cisco IOS Release 12.2(8)YN* document for caveat information for multiple PVCs.

OAM

For information about Operation, Administration, and Maintenance (OAM), refer to the *Configuring Operation, Administration, and Maintenance* document.

PPPoE Client

For information about the Point-to-Point Protocol over Ethernet (PPPoE) Client feature, refer to the *PPP over Ethernet Client* document.

PPPoE over ATM

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

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 “Wide-Area Networking Overview” chapter in [Cisco IOS Wide-Area Networking Configuration Guide](#).

Session Initiation Protocol

For information about Session Initiation Protocol (SIP), refer to *Cisco IOS SIP Configuration Guide* in the [Cisco IOS Voice Configuration Library](#).

Survivable Remote Site Telephony

For information about Survivable Remote Site Telephony (SRST), refer to the *Survivable Remote Site Telephony Cisco 2600/3600 Voice Technical Marketing* solutions document.

VoATM over AAL2

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

- “Configuring Voice over ATM” chapter in the [Cisco IOS Voice Configuration Library](#)
- 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 [Cisco IOS Voice Configuration Library](#).

**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 [Cisco IOS Voice Configuration Library](#).

Benefits of QoS

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.

How to Configure Enhanced Voice and QoS for ADSL and G.SHDSL

This section contains the following tasks. Each task in the list is identified as either required or optional.

- [Configuring ATM CLP Bit Marking, page 17](#) (optional)
- [Verifying ATM CLP Bit Marking, page 20](#) (optional)
- [Configuring the Clock Rate for ADSL and G.SHDSL WICs, page 20](#) (optional)
- [Verifying the Clock Setting for ADSL and G.SHDSL WICs, page 22](#) (optional)
- [Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco 3600 Series, page 24](#) (optional)
- [Configuring cRTP over an ATM Link with ATM Encapsulation, page 25](#) (optional)
- [Verifying cRTP Statistics, page 32](#) (optional)
- [Configuring FRF.5 One-To-One Connections, page 33](#) (optional)
- [Verifying FRF.5, page 39](#) (optional)
- [Configuring FRF.8, page 41](#) (optional)
- [Verifying FRF.8, page 44](#) (optional)
- [Configuring MLP Bundling, page 46](#) (optional)
- [Verifying MLP Bundling, page 48](#) (optional)
- [Configuring the Tx Ring Limit, page 55](#) (optional)
- [Verifying the Tx Ring Limit, page 56](#) (optional)
- [Troubleshooting Tips for MLP Bundling, page 51](#) (optional)

Configuring ATM CLP Bit Marking

This task shows you how to configure ATM CLP bit marking.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip cef
4. class-map *class-map-name*
5. match access-group *access-group*
6. exit
7. policy-map *policy-map-name*
8. class *name*
9. set atm-clp
10. exit
11. exit

12. **interface** *type slot/port.subinterface-number* [**multipoint** | **point-to-point**]
13. **pvc** *vpi/vci*
14. **service-policy output** *policy-map-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ip cef Example: Router(config)# ip cef	Enables Cisco Express Forwarding (CEF).
Step 4	class-map <i>class-map-name</i> Example: Router(config)# class-map <i>abc</i>	Creates a class map to be used for matching packets to a specified class and enters class map configuration mode. The <i>class-map-name</i> 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 5	match access-group <i>access-group</i> Example: Router(config-cmap)# match access-group <i>199</i>	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 6	exit Example: Router(config-cmap)# exit	Exits class map configuration mode.
Step 7	policy-map <i>policy-map-name</i> Example: Router(config)# policy-map <i>anyrule</i>	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 <i>policy-map-name</i> argument is the name of the policy map.
Step 8	class <i>name</i> Example: Router(config-pmap)# class <i>abc</i>	Specifies the name of a traffic class to classify traffic for the policy traffic and enters policy-map class configuration mode. The <i>name</i> argument should be the same as the class-map name in Step 4 of this configuration.
Step 9	set atm-clp Example: 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).

	Command or Action	Purpose
Step 10	<pre>exit</pre> Example: Router(config-pmap-c)# exit	Exits policy-map class configuration mode.
Step 11	<pre>exit</pre> Example: Router(config-pmap)# exit	Exits policy-map configuration mode.
Step 12	<pre>interface type slot/port.subinterface-number [multipoint point-to-point]</pre> Example: Router(config)# interface atm 0/1.299 multipoint	Configures an interface type and enters subinterface configuration mode. The arguments and keywords are as follows: <i>type</i>—To configure ATM CLP bit marking, use atm for the <i>type</i> argument. <i>slot</i>—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. <i>port</i>—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. <i>subinterface-number</i>—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 13	<pre>pvc vpi/vci</pre> Example: Router(config-subif)# pvc 1/1	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: <i>vpi</i>—ATM network virtual path identifier (VPI) for this PVC. The absence of the “/” and a VPI value defaults the VPI value to 0. <i>vci</i>—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 <i>vpi</i> and <i>vci</i> arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 14	<pre>service-policy output policy-map-name</pre> Example: Router(config-if-atm-vc)# service-policy output abc	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. <i>policy-map-name</i>—Name of a service policy map (created using the policy-map command) to be attached.

Verifying ATM CLP Bit Marking

The following is sample output using the **show atm pvc** command on a Cisco 1721 router that show 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm *slot/port***
4. **clock rate [aal2 | aal5] *clock-rate-value***
5. **no clock rate aal5 | aal2**

DETAILED STEPS

	Command or Action	Purpose
Step 1	<pre>enable</pre> Example: Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	<pre>configure terminal</pre> Example: Router# configure terminal	Enters global configuration mode.
Step 3	<pre>interface atm slot/port</pre> Example: Router(config)# interface atm 0/1	Configures an ATM interface type and enters interface configuration mode.
Step 4	<pre>clock rate [aal2 aal5] clock-rate-value</pre> Example: Router(config-if)# clock rate aal2 4000000	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. • <i>clock-rate-value</i>—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.

Command or Action	Purpose
	– 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 the section Troubleshooting the Clock Setting for ADSL and G.SHDSL WICs on Cisco 2600 Series and Cisco 3600 Series, page 24.)
Step 5 <code>no clock rate aal5 aal2</code> Example: Router(config-if)# <code>no clock rate aal5</code>	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: DSL SAR (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: DSL SAR (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 3600 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: insufficient 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

This task shows you how to configure cRTP over an ATM link with ATM encapsulation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef**
4. **class-map** [**match-all**] *class-map-name*
5. **match access-group name** *access-group-number*
6. **class-map** [**match-all**] *class-map-name*
7. **match access-group name** *access-group-number*
8. **policy-map** *policy-map-name*
9. **class** *class-name*
10. **priority** {*bandwidth-kbps* | **percent** *percentage*}
11. **fair-queue** [**queue-limit** *queue-value*]
12. **exit**
13. **exit**
14. **interface** *type interface-number*
15. **ip address** *ip-address mask* [**secondary**]
16. **interface atm slot/port**
17. **no ip address**
18. **load-interval** *seconds*
19. **no atm ilmi-keepalive**
20. **pvc** *vpi/vci*
21. **vbr-rt** *peak-rate average-rate burst*
22. **tx-ring-limit** *ring-limit*
23. **protocol** *protocol* {**virtual-template** {*virtual-template-interface-number*} | **dialer**}
24. **exit**
25. **dsl equipment-type** {**co** | **cpe**}
26. **dsl operating-mode auto gshdsl symmetric annex** {**A** | **B**}
27. **dsl linerate** {*kbps* | **auto**}
28. **exit**
29. **interface virtual-template** *number*
30. **ip unnumbered** *type-number*
31. **ip tcp header-compression**
32. **service-policy** {**input** | **output**}
33. **ppp multilink**

34. **ppp multilink fragment-delay** *delay-max*
35. **ppp multilink interleave**
36. **ip rtp header-compression** [**passive**]
37. **ip rtp compression-connections** *number*
38. **exit**
39. **voice-port** *slot-number/subunit-number/port*
40. **dial-peer voice** *tag* {**pots** | **voatm** | **vofr** | **voip**}
41. **destination-pattern** [**+**] *string* [**T**]
42. **port** {*slot-number/subunit-number/port*}
43. **exit**
44. **dial-peer voice** *tag* {**pots** | **voatm** | **vofr** | **voip**}
45. **destination-pattern** [**+**] *string* [**T**]
46. **session target** {**ipv4:destination-address**}
47. **dtmf-relay** [**cisco-rtp**] [**h245-alphanumeric**] [**h245-signal**]
48. **ip qos dscp** [*number* | *set-af* | *set-cs* | **default** | **ef**] [**media** | **signaling**]
49. **ip qos dscp** [*number* | *set-af* | *set-cs* | **default** | **ef**] [**media** | **signaling**]
50. **no vad**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ip cef Example: Router(config)# ip cef	Enables Cisco Express Forwarding (CEF) on the Route Processor card.
Step 4	class-map [match-all] <i>class-map-name</i> Example: Router(config)# class-map match-all voice-traffic	Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.

	Command or Action	Purpose
Step 5	match access-group name <i>access-group-number</i> Example: Router(config-cmap)# match access-group 102	Configures the match criteria for a class map on the basis of the specified access control list (ACL).
Step 6	class-map [match-all] class-map-name Example: Router(config-cmap)# class-map match-all voice-signaling	Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.
Step 7	match access-group name <i>access-group-number</i> Example: Router(config-cmap)# match access-group 103	Configures the match criteria for a class map on the basis of the specified ACL.
Step 8	policy-map policy-map-name Example: Router(config-cmap)# policy-map VOICE-POLICY	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 9	class class-name Example: Router(config-pmap)# class voice-traffic	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 10	priority {bandwidth-kbps percent <i>percentage}</i> Example: Router(config-pmap)# priority 8 48	Gives priority to a class of traffic belonging to a policy map.
Step 11	fair-queue [queue-limit queue-value] Example: Router(config-pmap)# fair-queue	Specifies the number of queues to be reserved for use by a traffic class.
Step 12	exit Example: Router(config-pmap)# exit	Exits policy-map configuration mode.
Step 13	exit Example: Router(config-cmap)# exit	Exits class-map configuration mode.

	Command or Action	Purpose
Step 14	interface <i>type interface-number</i> Example: Router(config)# interface loopback1	Enters interface configuration mode. Use Loopback for the <i>type</i> argument. Use 1 for the <i>interface-number</i> argument. Loopback 1 is a standard configuration for Multilink PPP (MLP) over ATM.
Step 15	ip address <i>ip-address mask [secondary]</i> Example: Router(config-if)# ip address 172.100.10.10 255.255.255.0	Sets a primary or secondary IP address for an interface.
Step 16	interface atm slot/port Example: Router(config-if)# interface atm 0/1	Configures an ATM interface type.
Step 17	no ip address Example: Router(config-if-atm)# no ip address	Removes an IP address or disables IP processing.
Step 18	load-interval <i>seconds</i> Example: Router(config-if-atm)# load-interval 15	Changes the length of time for which data is used to compute load statistics.
Step 19	no atm ilmi-keepalive Example: Router(config-if-atm)# no atm ilmi-keepalive	Disables ILMI keepalive.
Step 20	pvc <i>vpi/vci</i> Example: Router(config-if-atm)# pvc 1/100	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC and enters ATM VC configuration mode.
Step 21	vbr-rt <i>peak-rate average-rate burst</i> Example: Router(config-if-atm-vc)# vbr-rt 1500 1500	Configures the real-time variable bit rate (VBR) for Voice over ATM connections.
Step 22	tx-ring-limit <i>ring-limit</i> Example: Router(config-if-atm-vc)# tx-ring-limit 3	Limits the number of particles or packets that can be used on a transmission ring on an interface. The <i>ring-limit</i> argument specifies the maximum number of allowable particles or packets that can be placed on the transmission ring.

	Command or Action	Purpose
Step 23	<pre>protocol protocol {virtual-template {virtual-template-interface-number}/ dialer}</pre> Example: Router(config-if-atm-vc)# protocol ppp Virtual-Template1	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 <i>protocol</i> argument should be ppp . If ppp is shown as the <i>protocol</i> argument, the virtual-template keyword and the <i>virtual-template-interface-number</i> argument must be used. The <i>virtual-template-interface-number</i> argument may be any number from 1 through 200.
Step 24	<pre>exit</pre> Example: Router(config-if-atm-vc)# exit	Exits ATM VC configuration mode.
Step 25	<pre>dsl equipment-type {co cpe}</pre> Example: Router(config-if)# dsl co	Configures the DSL ATM interface to function as central office equipment or customer premises equipment.
Step 26	<pre>dsl operating-mode auto gshdsl symmetric annex {A B}</pre> Example: Router(config-if)# dsl operating-mode gshdsl symmetric annex A	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 27	<pre>dsl linerate {kbps auto}</pre> Example: Router(config-if)# dsl linerate auto	Specifies a line rate for the DSL ATM interface.
Step 28	<pre>exit</pre> Example: Router(config-if)# exit	Exits interface configuration mode.
Step 29	<pre>interface virtual-template number</pre> Example: Router(config)# interface virtual-template1	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 30	<pre>ip unnumbered type-number</pre> Example: Router(config-if)# ip unnumbered loopback1	Enables IP processing on a serial interface without assigning an explicit IP address to the interface. Note Use Loopback1 for the <i>type-number</i> argument. Loopback is a standard configuration for MLP over ATM.
Step 31	<pre>ip tcp header-compression</pre> Example: Router(config-if)# ip tcp header-compression iphc-format	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.

	Command or Action	Purpose
Step 32	service-policy {input output} Example: Router(config-if)# service-policy 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 33	ppp multilink Example: 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 34	ppp multilink fragment-delay <i>delay-max</i> Example: Router(config-if)# ppp multilink fragment-delay 3	Specifies a maximum size in units of time for packet fragments on a MLP bundle. The <i>delay-max</i> 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 35	ppp multilink interleave Example: Router(config-if)# ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on a MLP bundle.
Step 36	ip rtp header-compression [passive] Example: 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 37	ip rtp compression-connections <i>number</i> Example: Router(config-if)# ip rtp compression-connections 3	Specifies the total number of Real-Time Transport Protocol (RTP) header compression connections that can exist on an interface.
Step 38	exit Example: Router(config-if)# exit	Exits interface configuration mode.
Step 39	voice-port <i>slot-number/subunit-number/port</i> Example: Router(config)# voice-port 0/1/0	Enters voice-port configuration mode. Enter this command for all ports.
Step 40	dial-peer voice <i>tag</i> {pots voatm vofr voip} Example: Router(config)# dial-peer voice 2 voip	Enters dial-peer configuration mode and specifies the method of voice encapsulation, which in this case is POTS.

	Command or Action	Purpose
Step 41	destination-pattern <i>[+] string [T]</i> Example: Router(config-dial-peer)# destination-pattern 8...	Specifies either the prefix or the full E.164 telephone number (depending on your dial plan) to be used for a dial peer.
Step 42	port <i>{slot-number/subunit-number/port}</i> Example: Router(config-dial-peer)# port 1/1/0	Associates a dial peer with a specific voice port.
Step 43	exit Example: Router(config-dial-peer)# exit	Exits dial-peer configuration mode.
Step 44	dial-peer voice <i>tag {pots voatm voifr voip}</i> Example: Router(config)# dial-peer voice 3 voip	Enters dial-peer configuration mode and specifies the method of voice encapsulation, which in this case is VoIP.
Step 45	destination-pattern <i>[+] string [T]</i> Example: Router(config-dial-peer)# destination-pattern 5...	Specifies either the prefix or the full E.164 telephone number (depending on your dial plan) to be used for a dial peer.
Step 46	session target <i>{ipv4:destination-address}</i> Example: Router(config-dial-peer)# session target ipv4:192.168.1.1	Specifies a network-specific address for a specified VoIP dial peer.
Step 47	dtmf-relay <i>[cisco-rtp] [h245-alphanumeric] [h245-signal]</i> Example: Router(config-dial-peer)# dtmf-relay cisco-rtp	Specifies how an H.323 gateway relays dual tone multifrequency (DTMF) tones between telephony interfaces and an IP network.
Step 48	ip qos dscp <i>[number set-af set-cs default ef] [media signaling]</i> Example: Router(config-dial-peer)# ip qos dscp cs5 media	Specifies IP DSCP. In this case, choose the media keyword.

	Command or Action	Purpose
Step 49	ip qos dscp [<i>number</i> <i>set-af</i> <i>set-cs</i> <i>default</i> <i>ef</i>] [<i>media</i> signaling] Example: Router(config-dial-peer)# ip qos dscp cs5 signaling	Specifies IP DSCP. In this case, choose the signaling keyword.
Step 50	no vad Example: 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-Templat1:

```
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 One-To-One Connections

This task shows you how to configure FRF.5 for a one-to-one connection between two Frame Relay end users over an intermediate ATM network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **frame-relay switching**
4. **interface** *type slot/port*
5. **encapsulation frame-relay** [ietf]
6. **frame-relay interface-dlci** *dlci* **switched**
7. **frame-relay intf-type** [dce]
8. **exit**
9. **interface** *type slot/port.subinterface-number* { **multipoint** | **point-to-point** }
10. **pvc** *vpi/vci*
11. **encapsulation aal5mux frame-relay**
12. **exit**
13. **exit**
14. **connect** *connection-name* { *FR-interface FR-DLCI* } *ATM-interface ATM-VPI/VCI* [network-interworking]
15. **clp-bit** { 0 | 1 | map-de } or **de-bit** map-clp

DETAILED STEPS

	Command	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	frame-relay switching Example: Router(config)# frame-relay switching	Enables Frame Relay permanent virtual circuit (PVC) switching.
Step 4	interface type slot/port Example: Router(config)# interface serial0	Enters interface configuration mode.
Step 5	encapsulation frame-relay [ietf] Example: 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 6	frame-relay interface-dlci dlci switched Example: Router(config-if)# frame-relay interface-dlci 100 switched	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The <i>dlci</i> argument is the DLCI number to be used on the specified interface or subinterface.
Step 7	frame-relay intf-type [dce] Example: 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 8	exit Example: Router(config-if)# exit	Exits interface configuration mode.

	Command	Purpose
Step 9	interface <i>type</i> <i>slot/port.subinterface-number</i> { multipoint point-to-point } Example: Router(config)# interface atm 1/1.299 multipoint	Creates an ATM subinterface and enters subinterface configuration mode. The arguments and keywords are as follows: • <i>type</i>—Type of interface. Use atm for this configuration. • <i>slot</i>—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • <i>port</i>—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • <i>subinterface-number</i>—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 10	pvc <i>vpi/vci</i> Example: Router(config-subif)# pvc 0/1	Creates an ATM PVC and enters ATM VC configuration mode. The arguments are as follows: • <i>vpi/</i>—ATM network virtual path identifier (VPI) for this PVC. The absence of the “/” and a VPI value defaults the VPI value to 0. • <i>vci</i>—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 <i>vpi</i> and <i>vci</i> arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 11	encapsulation aal5mux frame-relay Example: 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 12	exit Example: Router(config-if-atm-vc)# exit	Exits ATM VC configuration mode.
Step 13	exit Example: Router(config-subif)# exit	Exits interface configuration mode.

	Command	Purpose
Step 14	connect <i>connection-name</i> {<i>FR-interface</i> <i>FR-DLCI</i>} <i>ATM-interface</i> <i>ATM-VPI/VCI</i> [<i>network-interworking</i>] Example: Router(config)# connect <i>frf serial0 100 atm 0/33 network-interworking</i>	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: • <i>connection-name</i>—Connection name. Enter as a 15-character maximum string. • <i>FR-interface</i>—Frame Relay interface type and number, for example, serial1/0. • <i>FR-DLCI</i>—Frame Relay DLCI in the range from 16 to 1007. • <i>ATM-interface</i>—ATM interface type and number, for example, atm1/0. • <i>ATM-VPI/VCI</i>—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 15	clp-bit {0 1 map-de} or de-bit map-clp Example: Router(config-frf5) # clp-bit 0	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.

Configuring FRF.5 for Many-To-One Connections

This task shows you how to configure FRF.5 for a many-to-one connection between two Frame Relay end users over an intermediate ATM network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **frame-relay switching**
4. **interface** *type slot/port*
5. **encapsulation frame-relay** [*ietf*]
6. **frame-relay interface-dlci** *dlci* **switched**
7. **frame-relay intf-type** [*dce*]
8. **exit**
9. **vc-group** *group-name*
10. **FR-interface-name** **FR-DLCI** **FR-SSCS-DLCI**

11. `exit`
12. `interface atm slot/port.subinterface-number {multipoint | point-to-point}`
13. `pvc vpi/vci`
14. `encapsulation aal5mux frame-relay`
15. `exit`
16. `exit`
17. `connect connection-name vc-group group-name ATM-interface ATM-VPI/VCI`
18. `clp-bit {0 | 1 | map-de}` or `de-bit map-clp`

DETAILED STEPS

	Command	Purpose
Step 1	<code>enable</code> Example: <code>Router> enable</code>	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	<code>configure terminal</code> Example: <code>Router# configure terminal</code>	Enters global configuration mode.
Step 3	<code>frame-relay switching</code> Example: <code>Router(config)# frame-relay switching</code>	Enables Frame Relay permanent virtual circuit (PVC) switching.
Step 4	<code>interface type slot/port</code> Example: <code>Router(config)# interface serial0</code>	Enters interface configuration mode.
Step 5	<code>encapsulation frame-relay [ietf]</code> Example: <code>Router(config-if)# encapsulation frame-relay</code>	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 6	<code>frame-relay interface-dlci dlci switched</code> Example: <code>Router(config-if)# frame-relay interface-dlci 122 switched</code>	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The <i>dlci</i> argument is the DLCI number to be used on the specified interface or subinterface.
Step 7	<code>frame-relay intf-type [dce]</code> Example: <code>Router(config-fr-dlci)# frame-relay intf-type dce</code>	Configures a Frame Relay switch type. Use the dce keyword if the router or access server functions as a switch connected to a router.

	Command	Purpose
Step 8	<pre>exit</pre> Example: Router(config-if)# exit	Exits interface configuration mode.
Step 9	<pre>vc-group group-name</pre> Example: Router(config)# vc-group groupa	Assigns multiple Frame Relay DLCIs to a VC group and enters ATM-Frame Relay VC group configuration mode.
Step 10	<pre>interface type slot/port FR-DLCI FR-SSCS-DLCI</pre> Example: Router(config-vc-group)# serial 1/0 100 100	Specifies the Frame Relay DLCIs in the VC group and maps them to the Frame Relay-SSCS DLCIs.
Step 11	<pre>exit</pre> Example: Router (config-vc-group)# exit	Exits ATM-Frame Relay VC group configuration mode.
Step 12	<pre>interface atm slot/port.subinterface-number {multipoint point-to-point}</pre> Example: Router(config)# interface atm 0/1.22 multipoint	Creates an ATM subinterface and enters subinterface configuration mode. The arguments and keywords are as follows: • <i>slot</i>—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. • <i>port</i>—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. • <i>subinterface-number</i>—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 13	<pre>pvc vpi/vci</pre> Example: Router(config-subif)# pvc 0/33	Creates an ATM permanent virtual circuit (PVC) or assigns a name to an ATM PVC. The arguments are as follows: • <i>vpi</i>—ATM network virtual path identifier (VPI) for this PVC. The absence of the “/” and a VPI value defaults the VPI value to 0. • <i>vci</i>—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 <i>vpi</i> and <i>vci</i> arguments cannot both be set to 0; if one is 0, the other cannot be 0.

	Command	Purpose
Step 14	encapsulation aal5mux frame-relay Example: 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 15	exit Example: Router(config-if-atm-vc)# exit	Exits ATM VC configuration mode.
Step 16	exit Example: Router(config-if)# exit	Exits interface configuration mode.
Step 17	connect connection-name vc-group group-name ATM-interface ATM-VPI/VCI Example: Router(config)# connect frf5-v vc-group groupa atm0 0/33	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: • <i>connection-name</i>—A connection name. Enter as a 15-character maximum string. • <i>vc-group</i>—Specifies a VC group name for a many-to-one FRF.5 connection. Enter as an 11-character maximum string. • <i>ATM-interface</i>—The ATM interface type and number, for example, atm1/0. • <i>ATM-VPI/VCI</i>—The ATM virtual path identifier/virtual channel identifier (VPI/VCI). If a VPI is not specified, the default VPI is 0.
Step 18	clp-bit {0 1 map-de} or de-bit map-clp Example: Router(config-frf5)# clp-bit 0	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

This task shows you how to configure FRF.8.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **frame-relay switching**
4. **interface serial *slot/port***
5. **encapsulation frame-relay [ietf]**
6. **no fair-queue**
7. **frame-relay interface-dlci *dlci* switched**
8. **frame-relay intf-type dce**
9. **exit**
10. **interface *type slot/port.subinterface-number* {multipoint | point-to-point}**
11. **pvc *vpi/vci***
12. **encapsulation aal5mux fr-atm-srv**
13. **exit**
14. **exit**
15. **connect *connection-name FR-interface FR-DLCI ATM-interface ATM-VPI/VC*
service-interworking**
16. **clp-bit {0 | 1 | map-de} or de-bit {0 | 1 | map-clp} or efci-bit {0 | map-fecn}**

DETAILED STEPS

	Command or Action	Purpose
Step 1	<code>enable</code>	Enables privileged EXEC mode. Enter your password when prompted.
	Example: <code>Router> enable</code>	
Step 2	<code>configure terminal</code>	Enters global configuration mode.
	Example: <code>Router# configure terminal</code>	
Step 3	<code>frame-relay switching</code>	Enables Frame Relay permanent virtual circuit (PVC) switching.
	Example: <code>Router(config)# frame-relay switching</code>	

	Command or Action	Purpose
Step 4	interface serial slot/port Example: Router(config)# interface serial 0/1	Enters interface configuration mode.
Step 5	encapsulation frame-relay [ietf] Example: 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 6	no fair-queue Example: Router(config-if)# no fair-queue	Deletes the configured number of queues from the traffic class.
Step 7	frame-relay interface-dlci dlci switched Example: Router(config-if)# frame-relay interface-dlci 199 switched	Indicates that a Frame Relay data-link connection identifier (DLCI) is switched and enters Frame Relay dlci configuration mode. The <i>dlci</i> argument is the DLCI number to be used on the specified interface or subinterface.
Step 8	frame-relay intf-type dce Example: 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 9	exit Example: Router(config-if)# exit	Exits interface configuration mode.
Step 10	interface type slot/port.subinterface-number {multipoint / point-to-point} Example: Router(config)# interface atm 0/1.299 multipoint	Configures an interface type and enters subinterface configuration mode. The arguments and keywords are as follows: <i>type</i>—To configure FRF.8, use <i>atm</i> for the <i>type</i> argument. <i>slot</i>—Number of the slot being configured. Refer to the appropriate hardware manual for slot and port information. <i>port</i>—Number of the port being configured. Refer to the appropriate hardware manual for slot and port information. <i>subinterface-number</i>—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.

	Command or Action	Purpose
Step 11	pvc <i>vpi/vci</i> Example: Router(config-subif)# pvc 1/1	Creates an ATM PVC, assigns a name to an ATM PVC, and enters ATM VC configuration mode. The arguments are as follows: <i>vpi</i>—ATM network virtual path identifier (VPI) for this PVC. The absence of the “/” and a VPI value defaults the VPI value to 0. <i>vci</i>—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 <i>vpi</i> and <i>vci</i> arguments cannot both be set to 0; if one is 0, the other cannot be 0.
Step 12	encapsulation aal5mux fr-atm-srv Example: Router(config-if-atm-vc)# encapsulation aal5mux fr-atm-srv	Configures the ATM adaptation layer (AAL) and encapsulation type for an ATM PVC.
Step 13	exit Example: Router(config-if-atm-vc)# exit	Exits ATM VC configuration mode.
Step 14	exit Example: Router(config-if) exit	Exits interface configuration mode.

	Command or Action	Purpose
Step 15	connect <i>connection-name</i> <i>FR-interface</i> <i>FR-DLCI</i> <i>ATM-interface</i> <i>ATM-VPI/VCI</i> service-interworking Example: Router(config)# connect <i>frf8</i> <i>serial0</i> <i>100</i> <i>atm0</i> <i>0/33</i> 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: • <i>connection-name</i>—Connection name. Enter as a 15-character maximum string. • <i>FR-interface</i>—Frame Relay interface type and number, for example, serial1/0. • <i>FR-DLCI</i>—Frame Relay data-link connection identifier (DLCI) in the range 16 to 1007. • <i>ATM-interface</i>—ATM interface type and number, for example atm1/0. • <i>ATM-VPI/VCI</i>—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 16	clp-bit {0 1 map-de} or de-bit {0 1 map-clp} or efci-bit {0 map-fecn} Example: Router(config-frf8)# clp-bit 0	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

This task shows you how to configure MLP bundling using a multilink interface.

SUMMARY STEPS

- 1. **enable**
- 2. **configure terminal**
- 3. **interface multilink** *multilink-bundle-number*
- 4. **ip address** *ip-address mask* [**secondary**]
- 5. **service-policy** {**input** | **output**} *policy-map-name*
- 6. **ppp multilink**
- 7. **ppp multilink fragment-delay** *delay-max*
- 8. **ppp multilink interleave**
- 9. **interface virtual-template** *number*
- 10. **no ip address**
- 11. **ppp multilink**
- 12. **ppp multilink multiclass**
- 13. **ppp multilink group** *group-number*
- 14. **exit**
- 15. **interface** *type slot/port.subinterface-number* [**point-to-point**]
- 16. **pvc** *vpi/vci*
- 17. **vbr-rt** *peak-rate average-rate burst*
- 18. **tx-ring-limit** *ring-limit*
- 19. **protocol** *protocol protocol-address*
- 20. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface multilink <i>multilink-bundle-number</i> Example: Router(config)# interface multilink1	Creates a multilink bundle or enters multilink interface configuration mode. The <i>multilink-bundle-number</i> argument is the number of the multilink bundle (a nonzero number).
Step 4	ip address <i>ip-address mask [secondary]</i> Example: Router(config-if)# ip address 172.10.10.0	Sets a primary or secondary IP address for an interface.
Step 5	service-policy {input output} <i>policy-map-name</i> Example: Router(config-if)# service-policy output green	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 6	ppp multilink Example: 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 7	ppp multilink fragment-delay <i>delay-max</i> Example: Router(config-if)# ppp multilink fragment-delay 10	Specifies a maximum size in units of time for packet fragments on a MLP bundle. The <i>delay-max</i> 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 8	ppp multilink interleave Example: Router(config-if)# ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on an MLP bundle.
Step 9	interface virtual-template <i>number</i> Router(config)# interface virtual-template10	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces and enters interface configuration mode. The <i>number</i> argument is the number used to identify the virtual template interface. Up to 200 virtual template interfaces can be configured.
Step 10	no ip address Example: Router(config-if)# no ip address	Removes an IP address or disables IP processing.
Step 11	ppp multilink Example: Router(config-if)# ppp multilink	Enables MLP on an interface and, optionally, enables BACP and BAP for dynamic bandwidth allocation..
Step 12	ppp multilink multiclass Example: 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.

	Command or Action	Purpose
Step 13	ppp multilink group <i>group-number</i> Example: Router(config-if)# ppp multilink group 299	Restricts a physical link to joining only a designated multilink-group interface. The <i>group-number</i> argument is a multilink-group number (a nonzero number).
Step 14	exit Router(config-if)# exit	Exits interface configuration mode.
Step 15	interface <i>type</i> <i>slot/port.subinterface-number</i> [point-to-point] Example: Router(config)# interface atm 0/1.299	Configures an interface type and enters interface configuration mode. The <i>type</i> argument should be ATM.
Step 16	pvc <i>vpi/vci</i> Example: Router(config-if)# pvc 1/0	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.
Step 17	vbr-rt <i>peak-rate average-rate burst</i> Example: Router(config-if-atm-vc)# vbr-rt 640 640	Configures the real-time variable bit rate (VBR) for Voice over ATM connections.
Step 18	tx-ring-limit <i>ring-limit</i> Example: Router(config-if-atm-vc)# tx-ring-limit 55	Limits the number of packets that can be used on a transmission ring on the PVC. The <i>ring-limit</i> 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 1 through 60. On Cisco 2600 and Cisco 3600 series routers, possible values are 3 through 60.
Step 19	protocol <i>protocol protocol-address</i> Example: Router(config-if-atm-vc)# protocol ppp virtual-template1	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 <i>protocol</i> argument should be PPP. The <i>protocol-address</i> argument should be virtual-template1 (the destination address that is being mapped to a PVC).
Step 20	exit Example: Router(config-if-atm-vc)# exit	Exits interface ATM VC configuration mode. Note 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 DSL SAR (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
Vendor ID:     'ALCB'
Vendor Specific: 0x0000
Vendor Country: 0x00
Capacity Used:  80%
Noise Margin:   11.5 dB
Output Power:   8.0 dBm
Attenuation:    0.0 dB
Defect Status:  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 9 A
40: 0 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 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
90: B 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
D0: 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

```

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 0xFD2BAA3 (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 0xFD2BAA3 (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 0xFD2BB2D (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 0xFD2BB2D (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

This task shows you how to configure the tx ring limit.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm slot/port**
4. **pvc [name] vpi/vci**
5. **vbr-rt peak-rate average-rate burst** or **vbr-nrt output-pcr output-scr output-mbs [input-pcr] [input-scr] [input-mbs]**
6. **tx-ring-limit ring-limit**

DETAILED STEPS

	Command	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface atm slot/port Example: Router(config)# interface atm 0/1	Configures an ATM interface type and enters interface configuration mode.
Step 4	pvc [name] vpi/vci Example: Router(config-if)# pvc 1/1	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 5	vbr-rt <i>peak-rate average-rate burst</i> or vbr-nrt <i>output-pcr output-scr output-mbs [input-pcr] [input-scr] [input-mbs]</i> Example: Router(config-if-atm-vc)# vbr-rt 640 640	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 6	tx-ring-limit <i>ring-limit</i> Example: Router(config-if-atm-vc)# tx-ring-limit 3	Limits the number of packets that can be used on a transmission ring on the permanent virtual circuit (PVC). The argument is as follows: <i>ring-limit</i>—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 1 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 **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 **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

```

Additional References

The following sections provide additional references related to Enhanced Voice and QoS for ADSL and G.SHDSL feature:

- [Related Documents, page 68](#)
- [Standards, page 71](#)
- [MIBs, page 71](#)
- [RFCs, page 71](#)
- [Technical Assistance, page 71](#)

Related Documents

Related Topic	Document Title
AAL2	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
ADSL and G.SHDSL WAN interface cards	<i>Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers</i> - 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	<i>When Does a Router Set the CLP Bit in an ATM Cell?</i>
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
Class-based packet marking with DSCP	The chapter “Quality of Service Overview” in the Cisco IOS Quality of Service Solutions Configuration Guide
Class-based policing	The chapter “Configuring Traffic Policing” in the Cisco IOS Quality of Service Solutions Configuration Guide
Class-based weighted fair queueing	The chapter “Quality of Service Overview” in the Cisco IOS Quality of Service Solutions Configuration Guide
Class-based WRED with DSCP (egress)	- The chapter “Quality of Service Overview” in the Cisco IOS Quality of Service Solutions Configuration Guide Cisco IOS Quality of Service Solutions Command Reference <i>DiffServ Compliant Weighted Random Error Detection</i>

Related Topic	Document Title
Committed access rate (CAR)	The chapter “Quality of Service Overview” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
Dial-peer DSCPs and IP precedence marking	The chapter “Quality of Service for Voice over IP” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
F5 OAM CC segment functionality	<i>Cisco Product Bulletin No. 1518</i> 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 <i>Cisco IOS H.323 Configuration Guide</i> in the <i>Cisco IOS Voice Configuration Library</i>
IP QoS map to ATM CoS	The chapter “Configuring IP to ATM Class of Service” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
Low latency queueing	- The chapter “Congestion Management Overview” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i> - The chapter “Quality of Service for Voice over IP” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
Network-based application recognition (NBAR)	- Network-Based Application Recognition - Using Content Networking to Provide Quality of Service - The chapter “Configuring Network-Based Application Recognition” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
OAM	Configuring Operation, Administration, and Maintenance
Per-VC queueing	<i>Understanding Weighted Fair Queuing on ATM</i> - 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)	<i>Software Enhancements for the Cisco 800 Routers and SOHO Routers</i> <i>Cisco 827 – Acting as a PPPoE Client with a Dynamic IP Address</i>
PPPoE over ATM	<i>PPPoE on ATM</i>
Policy-based routing	The chapter “Quality of Service Overview” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
QoS configuration	<i>Cisco IOS Quality of Service Solutions Configuration Guide</i> <i>Cisco IOS Quality of Service Solutions Command Reference</i>

Related Topic	Document Title
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 <i>Cisco IOS Quality of Service Solutions Configuration Guide</i> - The chapter “Configuring RSVP Support for LLQ” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i> - The chapter “Configuring RSVP Support for Frame Relay” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i> - The chapter “Configuring RSVP-ATM QoS Interworking” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i>
RFC 1483 bridging	<i>Basic PVC Configuration Using Bridged RFC 1483</i> - DSL Network Architectures
Session Initiation Protocol (SIP)	The <i>Cisco IOS SIP Configuration Guide</i> in the <i>Cisco IOS Voice Configuration Library</i>
Survivable Remote Site Telephony (SRST)	Survivable Remote Site Telephony Cisco 2600/3600 Voice Technical Marketing
Traffic policer	- The chapter “Configuring Traffic Policing” in the <i>Cisco IOS Quality of Service Solutions Configuration Guide</i> <i>Comparing Class-Based Policing and Committed Access Rate</i>
VC bundling	<i>Configuring an ADSL WAN Interface Card on Cisco 1700 Series Routers</i>
VC shaping for VBR-NRT	<i>Understanding the VBR-nrt Service Category and Traffic Shaping for ATM VCs</i>
Voice configuration	<i>Cisco IOS Voice Configuration Library</i>
Voice over AAL5	<i>Voice over ATM</i> document in <i>Cisco IOS Voice Configuration Library</i>
VoATM	<i>Voice over ATM</i> document in <i>Cisco IOS Voice Configuration Library</i>
WRED	DiffServ Compliant Weighted Random Error Detection

Standards

Standards	Title
None	—

MIBs

MIBs ¹	MIBs Link
• 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://www.cisco.com/go/mibs

1. Not all supported MIBs are listed.

RFCs

RFCs	Title
RFC 1213	Management Information Base for Network Management of TCP/IP-based internets: MIB-II

Technical Assistance

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

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS Asynchronous Transfer Mode Command Reference* at http://www.cisco.com/en/US/docs/ios/atm/command/reference/atm_book.html. For information about all Cisco IOS commands, go to the Command Lookup Tool at <http://tools.cisco.com/Support/CLILookup> or to the *Cisco IOS Master Commands List*.

- **clock rate (interface ATM)**
- **connect (FRF.5)**
- **connect (FRF.8)**
- **de-bit**
- **ppp multilink multiclass**
- **tx-ring-limit**

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