Cisco Systems

ATM Switch Router Software Configuration Guide

For the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010

Cisco IOS Release 12.1(26)EB

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CONTENTS

Preface

This preface describes the audience, organization, and conventions for the *ATM Switch Router Software Configuration Guide*, and provides information on how to obtain related documentation.

Audience

This publication is intended for experienced network administrators who are responsible for configuring and maintaining the Layer 3 enabled ATM switch router.

New and Changed Information

Feature	Platform Supported	Description	Chapter or Section
Configuring Point-to-Multipoint CES Soft PVC Connections	Catalyst 8540 MSR Catalyst 8510 MSR LightStream 1010	Allows you to configure point-to-multipoint CES soft PVC connections.	Configuring Point-to-Multipoint CES Soft PVC Connections
Enabling and Disabling Roots and Leaves of Point-to-Multipoint Soft PVC Connections	Catalyst 8540 MSR Catalyst 8510 MSR LightStream 1010	Allows you to enable and disable roots and individual leaves of point-to-multipoint ATM soft PVC connections.	Enabling and Disabling the Root of a Point-to-Multipoint Soft-PVC Connections Enabling and Disabling a Leaf of a Point-to-Multipoint Soft PVC

Organization

The major sections of this guide are as follows:

Chapter	Title	Description
Chapter 1	Product Overview	Provides an overview of the ATM switch router features and functions.
Chapter 2	Understanding the User Interface	Describes how to access the commands available in each command mode and explains the primary uses for each command mode.
Chapter 3	Initially Configuring the ATM Switch Router	Describes the initial configuration of the ATM switch router.
Chapter 4	Configuring System Management Functions	Describes the tasks to manage the general system features, such as access control and basic management of the ATM switch router.
Chapter 6	Configuring ATM Network Interfaces	Describes how to configure typical ATM network interfaces after autoconfiguration has established the default network connections.
Chapter 7	Configuring Virtual Connections	Describes how to configure virtual connections after autoconfiguration has determined the default virtual connections.
Chapter 8	Configuring Operation, Administration, and Maintenance	Describes the OAM fault management and performance management functions of the ATM switch router.
Chapter 9	Configuring Resource Management	Describes how to configure the management of switch, interface, and connection resources.
Chapter 10	Configuring ILMI	Describes the Integrated Local Management Interface (ILMI) protocol implementation and configuration.
Chapter 11	Configuring ATM Routing and PNNI	Describes how to configure the Interim Interswitch Signaling Protocol (IISP) and the Private Network-Network Interface (PNNI) protocol.
Chapter 12	Using Access Control	Describes how to configure and maintain access control lists.
Chapter 13	Configuring IP over ATM	Describes how to configure the Ethernet port for IP over ATM connections.
Chapter 14	Configuring LAN Emulation	Describes how to configure LAN emulation on the ATM switch router.
Chapter 15	Configuring ATM Accounting, RMON, and SNMP	Describes the ATM accounting, ATM Remote Monitoring, and SNMP features and their configuration.
Chapter 16	Configuring Tag Switching and MPLS	Describes how to configure tag switching and MPLS on the ATM switch router.
Chapter 17	Configuring Signalling Features	Describes how to configure common and specialized signalling features.

Chapter	Title	Description
Chapter 18	Configuring Interfaces	Describes the steps required to configure the individual port adapter and interface module.
Chapter 19	Configuring Circuit Emulation Services	Describes the steps to configure the Circuit Emulation Services port adapter modules.
Chapter 20	Configuring Frame Relay to ATM Interworking Port Adapter Interfaces	Describes the steps to configure the Frame Relay to ATM interworking port adapter modules.
Chapter 21	Configuring IMA Port Adapter Interfaces	Describes the steps to configure inverse multiplexing over ATM port adapter interfaces.
Chapter 22	Configuring Quality of Service	Describes the quality of service (QoS) features built into your switch router and includes information on how to configure the QoS functionality.
Chapter 23	Configuring the ATM Traffic-Shaping Carrier Module	Describes the features and configuration procedures for the ATM traffic-shaping carrier module (TSCAM).
Chapter 24	Configuring Rate Limiting and Traffic Shaping	Describes rate limiting features and configuration procedures for your switch router.
Chapter 25	Configuring ATM Router Module Interfaces	Describes the steps to integrate Layer 3 routing and ATM switching with the ATM router module.
Chapter 26	Managing Configuration Files, System Images, and Functional Images	Includes procedures for updating and maintaining the ATM switch router software and configurations.
Appendix A	PNNI Migration Examples	Provides examples for migrating from a flat PNNI topology to a hierarchical topology.
Appendix B	Acronyms	Lists the acronyms used in this guide.

Related Documentation

This document provides detailed ATM software configuration examples; however, it does not provide complete ATM software command syntax descriptions or extensive background information on ATM features. For detailed ATM software command syntax information, refer to the *ATM Switch Router Command Reference* publication. For detailed background information on ATM features and functionality, refer to the *Guide to ATM Technology*.

You will also find useful information on the command-line interface (CLI) and basic ATM switch router management in the *Configuration Fundamentals Configuration Guide* and *Configuration Fundamentals Command Reference* publications.

The ATM switch router documentation set is primarily ATM-specific. You might be referred to the Cisco IOS documentation set for information about IP and router configuration and other non-ATM related features. For example, when configuring the IP address on the ATM switch processor, only basic configuration steps are provided. If you need additional overview or detailed IP configuration information, refer to the Cisco IOS documentation set.

The ATM switch router documents are separated into two groups:

- Basic documents are provided in the accessory kit with the hardware and are all the documentation you need for initial installation and configuration information.
- Advanced configuration documents are not provided in the accessory kit unless specifically ordered. They are available on Cisco.com and the Documentation CD-ROM and offer configuration information for more advanced applications of the ATM switch router.

The *ATM Switch Router Software Configuration Guide* is one of the advanced configuration documents and should only be used after you have completed the processes described in the basic document set. Refer to the following documents for detailed hardware installation, basic configuration information, and troubleshooting information:

- *Regulatory Compliance and Safety Information for Catalyst 8500 and LightStream 1010 Series*
- *Quick Reference Catalyst 8540 CSR and MSR Hardware Information* (poster)
- *Quick Reference Catalyst 8510 and LightStream 1010 Hardware Information* (poster)
- *ATM and Layer 3 Module Installation Guide*
- *ATM and Layer 3 Quick Software Configuration Guide*
- *Layer 3 Switching Software Feature and Configuration Guide*
- *ATM and Layer 3 Switch Router Command Reference*
- *Guide to ATM Technology*
- *Troubleshooting Guide*

Note The carrier modules are documented in the *ATM and Layer 3 Module Installation Guide*.

Document Conventions

Unless otherwise noted, all information in this document is relevant to the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. Platform specific sections have the platform name appended to the title in parentheses. For example, the "Testing the Configuration" section on page 3-24 is only relevant to the Catalyst 8540 MSR ATM switch router.

This document uses the following conventions:

Convention	Description
boldface font	Commands and keywords are in **boldface**.
italic font	Arguments for which you supply values are in *italics*.
[ ]	Elements in square brackets are optional.
{x | y | z}	Alternative keywords are grouped in braces and separated by vertical bars.
[x | y | z]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.

Convention	Description
`screen` font	Terminal sessions and information the system displays are in `screen` font.
`boldface screen` font	Information you must enter is in **`boldface screen`** font.
italic screen font	Arguments for which you supply values are in *italic screen* font.
➔	`This pointer highlights an important line of text in an example.`
^	The symbol ^ represents the key labeled Control—for example, the key combination ^D in a screen display means hold down the Control key while you press the D key.
< >	Nonprinting characters, such as passwords are in angle brackets.

Notes use the following conventions:

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the publication.

Cautions use the following conventions:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Obtaining Documentation

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http://tools.cisco.com/RPF/register/register.do

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Using the online TAC Service Request Tool is the fastest way to open S3 and S4 service requests. (S3 and S4 service requests are those in which your network is minimally impaired or for which you require product information.) After you describe your situation, the TAC Service Request Tool automatically provides recommended solutions. If your issue is not resolved using the recommended resources, your service request will be assigned to a Cisco TAC engineer. The TAC Service Request Tool is located at this URL:

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For S1 or S2 service requests or if you do not have Internet access, contact the Cisco TAC by telephone. (S1 or S2 service requests are those in which your production network is down or severely degraded.) Cisco TAC engineers are assigned immediately to S1 and S2 service requests to help keep your business operations running smoothly.

To open a service request by telephone, use one of the following numbers:

Asia-Pacific: +61 2 8446 7411 (Australia: 1 800 805 227)
EMEA: +32 2 704 55 55
USA: 1 800 553 2447

For a complete list of Cisco TAC contacts, go to this URL:

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Definitions of Service Request Severity

To ensure that all service requests are reported in a standard format, Cisco has established severity definitions.

Severity 1 (S1)—Your network is “down,” or there is a critical impact to your business operations. You and Cisco will commit all necessary resources around the clock to resolve the situation.

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Severity 4 (S4)—You require information or assistance with Cisco product capabilities, installation, or configuration. There is little or no effect on your business operations.

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- The Cisco *Product Catalog* describes the networking products offered by Cisco Systems, as well as ordering and customer support services. Access the Cisco Product Catalog at this URL:

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

- *Internet Protocol Journal* is a quarterly journal published by Cisco Systems for engineering professionals involved in designing, developing, and operating public and private internets and intranets. You can access the Internet Protocol Journal at this URL:

  http://www.cisco.com/ipj

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CHAPTER 1

Product Overview

This chapter provides an introduction to the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers.

Note This chapter provides hardware and software information for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For descriptions of software features, refer to the *Guide to ATM Technology*.

This chapter includes the following sections:

- Layer 3 Enabled ATM Switch Router Hardware Overview, page 1-1
- Summary of Software Features, page 1-5

Layer 3 Enabled ATM Switch Router Hardware Overview

This section provides an overview of the hardware available for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 Layer 3 enabled ATM switch routers and includes the following sections:

- Layer 3 Enabled ATM Switch Router Hardware (Catalyst 8540 MSR)
- Layer 3 Enabled ATM Switch Router Hardware (Catalyst 8510 MSR and LightStream 1010)

Layer 3 Enabled ATM Switch Router Hardware (Catalyst 8540 MSR)

The Layer 3 enabled ATM switch router uses a 13-slot, modular chassis featuring dual, fault-tolerant, load-sharing AC or DC power supplies. Slots 4 and 8 are occupied by the dual, field-replaceable route processors, which perform central processing functions and provide redundancy. The route processors can also accommodate the network clock module, which features a stratum 3 oscillator and two building integrated timing supply (BITS) ports. Slots 5, 6, and 7 are occupied by either two or three switch processors, for a 20-Gbps non-EHSA or 20-Gbps EHSA switch fabric. The switch processors also accommodate the switch processor feature card.

The remaining slots hold either a full-width module, such as the new four-port OC-12 module, or the carrier module, which in turn accommodates one or two port adapters, such as the four-port OC-3 port adapters. Along with other available interfaces, the ATM switch router provides switched ATM connections to individual workstations, servers, LAN segments, or other ATM switches and routers using fiber-optic, unshielded twisted-pair (UTP), and coaxial cable.

Available Hardware Components (Catalyst 8540 MSR)

The Catalyst 8540 MSR features the following available hardware components:

- Optional switch feature card, supporting usage parameter control (UPC) and statistics
- Optional network clock module
- Full-width 1-port OC-48c single-mode intermediate reach *plus* 4-port OC-12 single-mode fiber interface modules
- Full-width 1-port OC-48c single-mode intermediate reach *plus* 4-port OC-12 multimode fiber interface modules
- Full-width 1-port OC-48c single-mode long reach *plus* 4-port OC-12 multimode fiber interface modules
- Full-width 2-port OC-48c single-mode intermediate reach interface modules
- Full-width 2-port OC-48c single-mode long reach interface modules
- Full-width 4-port OC-12 single-mode intermediate reach interface modules
- Full-width 4-port OC-12 multimode short reach interface modules
- Full-width 16-port OC-3 multimode short reach interface modules
- Full-width ATM router modules
- Full-width 2-port Fast Ethernet interface modules
- Full-width 8-port Gigabit Ethernet interface modules
- Full-width 16-port Fast Ethernet interface modules
- Full-width Enhanced 2-port Gigabit Ethernet interface modules
- Full-width 1-port POS OC-12c/STM-4 SMF-IR and 1-port Gigabit Ethernet interface modules
- Full-width 1-port POS OC-12c/STM-4 SMF-LR and 1-port Gigabit Ethernet interface modules
- Support for the following Catalyst 8510 MSR and LightStream 1010 ATM switch router port adapters via the carrier module:
  - 1-port OC-12 port adapters (multimode, single-mode, and single-mode long reach)
  - 4-port OC-3 port adapters (multimode, single-mode, single-mode long reach, mixed, and UTP)
  - 4-port DS3/E3 port adapters
  - 4-port channelized E1 Frame Relay port adapters
  - 1-port channelized DS3 Frame Relay port adapters
  - 4-port T1/E1 port adapters
  - 4-port T1/E1 circuit emulation service (CES) port adapters
  - 8-port T1/E1 inverse multiplexing over ATM (IMA) port adapters

Layer 3 Enabled ATM Switch Router Hardware (Catalyst 8510 MSR and LightStream 1010)

The Catalyst 8510 MSR and LightStream 1010 ATM switch routers both use a five-slot, modular chassis featuring the option of dual, fault-tolerant, load-sharing AC or DC power supplies. A single, field-replaceable ATM switch processor module supports both the 5-Gbps shared memory and the fully nonblocking switch fabric. The processor also supports the feature card and high performance reduced instruction set computing (RISC) processor (CPU) that provides the central intelligence for the device. The remaining slots support up to four hot-swappable carrier modules. Each carrier module can hold up to two hot-swappable port adapters for a maximum of eight port adapters per switch, supporting a wide variety of desktop, backbone, and wide-area interfaces.

The ATM switch provides switched ATM connections to individual workstations, servers, LAN segments, or other ATM switches and routers using fiber-optic, unshielded twisted-pair (UTP), and coaxial cable.

Note The ATM switch processor and port adapters can be installed in the Catalyst 5500 switch chassis. In the Catalyst 5500 switch chassis the processor must be installed in slot number 13 and the port adapters in slot numbers 9 though 12. The examples in this guide assume that the ATM switch router is in its own chassis, with the processor in slot number 2 and the port adapters in slot numbers 0, 1, 3, and 4.

Processor and Feature Card Models (Catalyst 8510 MSR and LightStream 1010)

The Catalyst 8510 MSR and LightStream 1010 ATM switch routers are equipped with one of the following combinations of processor and feature card:

- ASP-B with feature card per-class queuing (FC-PCQ) or feature card per-flow queuing (FC-PFQ)
- ASP-C with FC-PCQ or FC-PFQ
- Multiservice ATM switch route processor

ASP-B with FC-PCQ and ASP-C with FC-PCQ are functionally equivalent, offering the same features and performance. FC-PFQ, however, provides an enhanced feature set, including advanced traffic management. ASP-B and ASP-C, equipped with FC-PFQ, also provide identical functionality for ATM applications. However, ASP-C with FC-PFQ provides the additional capability for supporting both ATM and Layer 3 switching on the same platform. ASP-C with FC-PFQ and the multiservice ATM switch route processor, used in the Catalyst 8510 MSR, are identical.

FC-PCQ provides a subset of the ATM Forum traffic management features provided by FC-PFQ, as described in Table 1-1.

Table 1-1 FC-PCQ and FC-PFQ Feature Comparison

Feature	FC-PCQ	FC-PFQ
Traffic classes	CBR[1], RT-VBR[2], NRT-VBR[3], ABR[4] (EFCI[5] and RR[6]), UBR[7]	CBR, RT-VBR, NRT-VBR, ABR (EFCI and RR), UBR
Output queuing	Four classes per port	Per-VC or per-VP
Output scheduling	Strict priority	Strict priority, rate scheduling, and WRR[8]
Intelligent early packet discard	Multiple fixed thresholds	Multiple, weighted, dynamic thresholds

Table 1-1 FC-PCQ and FC-PFQ Feature Comparison (continued)

Feature	FC-PCQ	FC-PFQ
Intelligent tail (partial) packet discard	Supported	Supported
Selective cell marking and discard	Multiple fixed thresholds	Multiple, weighted, dynamic thresholds
Shaping	Per-port (pacing)	Per-VC or per-VP (128 shaped VP tunnels)
Policing (UPC[9])	Dual mode, single leaky bucket	Dual leaky bucket
Frame mode VC-merge	–	Supported
Point-to-multipoint VC (multicast)	One leaf per output port, per point-to-multipoint	Multiple leaves per output port, per point-to-multipoint
Network clock switchover	Automatic upon failure	Programmable clock selection criteria
Nondisruptive snooping	Per-port transmit or receive	Per-VC, per-VP, or per-port

1. CBR = constant bit rate
2. RT-VBR = real time variable bit rate
3. NRT-VBR = non real time variable bit rate
4. ABR = available bit rate
5. EFCI = Explicit Forward Congestion Indication
6. RR = relative rate
7. UBR = unspecified bit rate
8. WRR = weighted round-robin
9. UPC = usage parameter control

The Catalyst 8510 MSR is equipped with the multiservice ATM switch route processor.

For additional information, refer to the *Processor Installation Guide*.

Available Physical Interfaces (Catalyst 8510 MSR and LightStream 1010)

The ATM switch router features the following available hardware components:

- The ATM switch router supports the following port adapters:
  - 4-port channelized E1 Frame Relay port adapters
  - 1-port channelized DS3 Frame Relay port adapters
  - 1-port OC-12 port adapters (multimode, single-mode, and single-mode long reach)
  - 4-port OC-3 port adapters (multimode, single-mode, single-mode long reach, mixed, and UTP)
  - 2-port DS3/E3 port adapters
  - 4-port DS3/E3 port adapters
  - 4-port T1/E1 port adapters
  - 4-port T1/E1 circuit emulation service (CES) port adapters
  - 25-Mbps port adapters
  - 8-port T1/E1 inverse multiplexing over ATM (IMA) port adapters

- Full-width ATM router modules
- Full-width 8-port Gigabit Ethernet interface modules
- Full-width 1-port Gigabit Ethernet interface modules

Summary of Software Features

The following sections provide a brief overview of the software features of the Layer 3 enabled ATM switch router, including the following features:

- System Availability (Catalyst 8540 MSR), page 1-5
- ATM Addressing and Plug-and-Play Operation, page 1-6
- Connections, page 1-6
- Resource Management, page 1-7
- Signalling and Routing, page 1-7
- ATM Internetworking Services (Catalyst 8540 MSR), page 1-8
- ATM Internetworking Services (Catalyst 8510 MSR and LightStream 1010), page 1-8
- Network Clocking, page 1-8
- Management and Monitoring, page 1-8
- Available Network Management Applications, page 1-9
- Layer 3 Features, page 1-10

System Availability (Catalyst 8540 MSR)

The Catalyst 8540 MSR provides Enhanced High System Availability (EHSA) during hardware and software upgrades as well as fault resistance with the following features:

- Dual power supplies
- Dual route processors
- Switching fabric with optional spare switch processor
- Optional dual network clock modules

In the event one of the route processors becomes unavailable due to failure or for software upgrade, the secondary route processor takes over with zero boot time. To support switching fabric availability, an optional third switch processor, running in standby mode, takes over if one of the other switch processor cards fails. Finally, the optional network clock modules are able to retain clock configuration should one of the modules fail.

ATM Addressing and Plug-and-Play Operation

The ATM switch router provides the following self-configuring features:

- Preconfigured ATM address prefixes and MAC address, permitting small-scale ATM internetworks to be deployed prior to obtaining officially-allocated ATM addresses
- Automatic reassignment of addresses when reconfiguration is necessary
- Automatic recognition of port adapter types and ATM interface type using ILMI
- Automatic IP address configuration features, such as BOOTP
- Online-insertion-and-replacement (OIR) diagnostic tests

Connections

The ATM switch router supports connections with the following characteristics:

- Full 8-bit virtual path identifier (VPI) and 16-bit virtual channel identifier (VCI) with configurable boundaries.
- 12-bit VPI support available on ATM Network-Network Interface (NNI) interfaces on the Catalyst 8510 MSR and LightStream 1010
- Up to 256,000 total virtual connections on the Catalyst 8540 MSR and up to 64,000 total virtual connections on the Catalyst 8510 MSR and LightStream 1010
- VC and virtual path (VP) switching, VP tunneling, and VC merging
- The following virtual connection types:
  - Permanent virtual channel (PVC) connections
  - Permanent virtual path (PVP) connections
  - Soft permanent virtual channel (soft PVC) and soft permanent virtual path (soft PVP) connections with route optimization
  - Switched virtual channel (SVC) and switched virtual path (SVP) connections
  - Virtual path (VP) tunneling with traffic shaping and QoS guarantees for multiple service categories (hierarchical VP tunnels)
  - Point-to-point ATM connections
  - Point-to-multipoint ATM connections
- F4 and F5 Operation, Administration, and Maintenance (OAM) segment-loopback and end-to-end remote deflect identification (RDI) and alarm indication signal (AIS)
- OAM-based ping of IP or ATM address on the Catalyst 8510 MSR and LightStream 1010
- Frame Relay to ATM interworking features on the channelized E1 port adapter:
  - PVCs and soft-VCs with Network Interworking
  - PVCs and soft-VCs with Service Interworking
  - Support for various LMIs

Resource Management

Resource management provides support for the following features:

- Traffic categories:
  - Constant bit rate (CBR)
  - Real-time variable bit rate (VBR-RT)
  - Non-real time variable bit rate (VBR-NRT)
  - Available bit rate (ABR) + minimum cell rate (MCR)
  - Unspecified bit rate (UBR) + MCR

Note FC-PCQ-equipped systems only support MCR value 0 for ABR and UBR traffic categories.

- Quality of service (QoS) guarantees with traffic policing and intelligent packet discard
- Connection admission control (CAC)
- Congestion control and traffic pacing

Note Some newer port adapters do not support traffic pacing.

- ABR with explicit forward congestion indication (EFCI) and relative rate (RR) marking

Note Relative rate marking of ABR traffic is not supported on the Catalyst 8540 MSR.

Signalling and Routing

The following signalling and routing features are supported:

- User-Network Interface (UNI) 3.0, 3.1, and 4.0
- Integrated Local Management Interface 4.0
- ATM network service access point (NSAP) and E.164 addressing
- Interim Interswitch Signalling Protocol (IISP) routing protocol
- Single-level and full hierarchical Private Network-Network Interface (PNNI) routing protocol, including PNNI complex node support
- Closed user groups (CUGs) for ATM virtual private networks (VPNs)
- ATM signalling and ILMI access lists with support for time of day-based policies
- ATM anycast

ATM Internetworking Services (Catalyst 8540 MSR)

The following internetworking services are provided:

- LAN emulation configuration server (LECS), LAN emulation server (LES), and broadcast-and-unknown server (BUS) for Ethernet emulated LANs (ELANs)
- Cisco Simple Server Redundancy Protocol (SSRP) for LANE
- RFC 1577 classical IP over ATM and Address Resolution Protocol (ARP) server and client
- Tag switching for Open Shortest Path First (OSPF), Routing Information Protocol (RIP), and Enhanced Interior Gateway Routing Protocol (EIGRP) routing of IP packets
- ATM Circuit Emulation Service (CES) as defined by ATM Forum CES 1.0
- RFC 1483 multiprotocol encapsulation over ATM

ATM Internetworking Services (Catalyst 8510 MSR and LightStream 1010)

The following internetworking services are provided:

- LAN emulation configuration server (LECS), LAN emulation server (LES), and broadcast and unknown server (BUS) for Ethernet and Token Ring emulated LANs (ELANs)
- Cisco Simple Server Redundancy Protocol (SSRP) for LANE
- RFC 1577 classical IP over ATM and Address Resolution Protocol (ARP) server and client
- Tag switching for Open Shortest Path First (OSPF) routing of IP packets
- ATM Circuit Emulation Service (CES) as defined by ATM Forum CES 1.0
- RFC 1483 multiprotocol encapsulation over ATM

Network Clocking

Any interface on the ATM switch router can be synchronized to an internal source (system clock) or to an external source, such as another network. Synchronous residual time stamp (SRTS), and adaptive clocking modes are supported for CES.

With the optional network clock module on the Catalyst 8540 MSR, the ATM switch router can be synchronized to a BITS source or to the module’s own stratum 3 clock.

Management and Monitoring

The following features provide support for managing the ATM switch router:

- Text-based command-line interface (CLI) for configuration and troubleshooting
- Simple Network Management Protocol (SNMP) agent provides dynamic status, statistics, and configuration information
- Configuration and system image files saved in NVRAM and Flash memory
- Boot from network or from Flash memory
- Upload and download system images using Trivial File Transfer Protocol (TFTP)

- Update hardware controller microcode independently of system image on channelized E1 port adapter
- In-band device network management using IP over ATM
- In-band device network management using LAN emulation client, RFC 1577 client, and RFC 1483 client
- Out-of-band device network management using Ethernet and console ports
- ATM forum and enterprise Management Information Bases (MIBs) including, but not limited to, the following features:
  - AToM MIB RFC1695
  - SVC MIB
  - ILMI MIB
  - PNNIv1.0 MIB
  - ATM Signaling and Diagnostic MIB
  - ATM RMON MIB
  - ATM Accounting MIB
- Port, VC, and VP snooping for monitoring and troubleshooting
- ATM accounting
  - Remote and local periodic collection of records
  - Accounting records for PVC/PVPs
  - 5-second peak interval transmit and receive cell counter for PVC/PVPs only
- Online diagnostics tests that run in the background and monitor system hardware status

Available Network Management Applications

The CiscoWorks 2000 family of network management software provides tools for managing your ATM switch router. CiscoWorks 2000 includes the following packages:

- CWSI Resource Manager Essentials—a suite of web-based network management tools that allow you to collect the monitoring, fault, and availability information needed to track devices.
- CWSI Campus—a suite of network management applications that allow you to configure, monitor, and manage a switched internetwork.

The functionality provided by the CWSI Campus suite of applications includes the following features:

- Automatically discover and display a map of your enterprise or campus network
- Display and configure emulated LANs
- Configure PNNI
- Obtain end-station user information
- Display and configure device information
- Monitor traffic

Layer 3 Features

With the ATM router module, the ATM switch router support the following Layer 3 features:

- Bridging
- Integrated routing and bridging (IRB)
- IP fragmentation support
- IP multicast routing
- IP and IPX load balancing
- Routing protocol MIB support
- ISL trunking for routing and bridging
- Standard and extended ACL support for IP
- Standard ACL support for IPX
- Packet over SONET (POS) RFC 1619 PPP support
- POS RFC 1662 PPP

Understanding the User Interface

This chapter describes the ATM switch router user interface and provides instructions for using the command-line interface (CLI).

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

The following sections are included:

User Interface Overview

The user interface for the ATM switch router provides access to several different command modes, each with related commands. Users familiar with the Cisco IOS user interface will find the interfaces very similar. This chapter describes how to access and list the commands available in each command mode, and explains the primary uses for each command mode.

For security purposes, the user interface provides two levels of command access: *user* and *privileged*. The unprivileged user mode is called user EXEC mode; the privileged mode is called privileged EXEC mode, and requires a password.

Note Because all commands available in user EXEC mode are also available in privileged EXEC mode, user EXEC mode is referred to as EXEC mode in this guide.

From the privileged level, you can access global configuration mode; from global configuration mode you can access numerous submodes that allow you to configure specific, related features. Read-only memory (ROM) monitor mode accesses a basic system kernel to which the ATM switch router may default at startup if it does not find a valid system image, or if its configuration file is corrupted.

You can enter commands in uppercase, lowercase, or a mix of both. Only passwords are case sensitive. You can abbreviate commands and keywords to a minimum unique string of characters. For example, you can abbreviate the **show** command to **sh**. After entering the command line at the system prompt, press the **Return** key to execute the command.

Almost every configuration command has a **no** form. In general, use the **no** form to disable a feature or function. Use the command without the **no** keyword to reenable a disabled feature or enable a feature disabled by default.

Note Refer to the *ATM Switch Router Command Reference* publication for the complete syntax of commands specific to the ATM switch router and a description of the function of the **no** form of a command. Refer to the *Configuration Fundamentals Command Reference* publication for the complete syntax of other IOS commands.

Accessing Each Command Mode

This section describes how to access the command modes for the ATM switch router. Table 2-1 and Table 2-2 list the command modes, access to each mode, the prompt you see while in that mode, the main uses for each configuration mode, and the method to exit that mode. The prompts listed assume the default ATM switch router name "Switch." Table 2-1 and Table 2-2 might not include all of the possible ways to access or exit each command mode.

Table 2-1 Summary of Command Modes

Command Mode	Access Method	Prompt	Exit Method
EXEC (user)	Log in to the ATM switch router.	`Switch>`	Use the **logout** command.
Privileged EXEC	From user EXEC mode, use the **enable** EXEC command and enter your password.	`Switch#`	To return to user EXEC mode, use the **disable** command.
ROM monitor	From privileged EXEC mode, use the **reload** EXEC command. Press **Break** during the first 60 seconds while the system boots.	`>`	To exit to user EXEC mode, type **continue**.
Global configuration	From privileged EXEC mode, use the **configure** privileged EXEC command. Use the keyword **terminal** to enter commands from your terminal.	`Switch(config)#`	To exit to privileged EXEC mode, use the **exit** or **end** command or press **Ctrl-Z**.
Interface configuration	From global configuration mode, specify an interface with an **interface** command.	`Switch(config-if)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

Table 2-1 Summary of Command Modes (continued)

Command Mode	Access Method	Prompt	Exit Method
Interface range configuration	From global configuration mode, specify a range of interfaces to configure with an **interface range** command.	`Switch(config-if)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Subinterface configuration	From interface configuration mode, specify a subinterface with an **interface** command.	`Switch(config-subif)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Line configuration	From global configuration mode, specify a line with a **line** command.	`Switch(config-line)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Map-list configuration	From global configuration mode, define a map list with the **map-list** command.	`Switch(config-map-list)#`	To exit to global configuration mode, use the **exit** command. To enter map-class configuration mode, use the **map-class** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Map-class configuration	From global configuration mode, configure a map class with the **map-class** command.	`Switch(config-map-class)#`	To exit to global configuration mode, use the **exit** command. To enter map-list configuration mode, use the **map-list** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
ATM router configuration	From global configuration mode, configure the PNNI routing protocol with the **atm router pnni** command.	`Switch(config-atm-router)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode use the **end** command or press **Ctrl-Z**.

Table 2-1 Summary of Command Modes (continued)

Command Mode	Access Method	Prompt	Exit Method
PNNI node configuration	From ATM router configuration mode, configure the PNNI routing node with the **node** command.	`Switch(config-pnni-node)#`	To exit to ATM router configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
PNNI explicit path configuration	From global configuration mode, enter the **atm pnni explicit-path** command.	`Switch(cfg-pnni-expl-path)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
ATM accounting file configuration	From global configuration mode, define an ATM accounting file with the **atm accounting file** command.	`Switch(config-acct-file)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
ATM accounting selection configuration	From global configuration mode, define an ATM accounting selection table entry with the **atm accounting selection** command.	`Switch(config-acct-sel)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
LANE configuration server database configuration	From global configuration mode, specify a LANE configuration server database name with the **lane database** command.	`Switch(lane-config-database)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
ATM E.164 translation table configuration	From global configuration mode, enter the **atm e164 translation-table** command	`Switch(config-atm-e164)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

Table 2-1 Summary of Command Modes (continued)

Command Mode	Access Method	Prompt	Exit Method
ATM signalling diagnostics configuration	From global configuration mode, enter the **atm signalling diagnostics** command and an index to configure.	`Switch(cfg-atmsig-diag)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Controller configuration	From global configuration mode, enter the **controller** command.	`Switch(config-controller)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

Table 2-2 Summary of Additional Command Modes (Catalyst 8540 MSR)

Command Mode	Access Method	Prompt	Exit Method
Redundancy configuration	From global configuration mode, enter the **redundancy** command.	`Switch(config-r)#`	To exit to global configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.
Main CPU configuration	From redundancy configuration mode, enter the **main-cpu** command.	`Switch(config-r-mc)#`	To exit to redundancy configuration mode, use the **exit** command. To exit directly to privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

EXEC Mode

When you log in to the ATM switch router, you are in user EXEC, or simply EXEC, command mode. The EXEC commands available at the user level are a subset of those available at the privileged level. In general, the user-level EXEC commands allow you to connect to remote devices, change terminal settings on a temporary basis, perform basic tests, and list system information.

The user-level prompt consists of the ATM switch router's host name followed by the angle bracket (>):

```
Switch>
```

The default host name is *Switch*, unless it has been changed during using the **hostname** global configuration command.

Privileged EXEC Mode

The privileged EXEC command set includes all user-level EXEC mode commands and the **configure** command, through which you can access global configuration mode and the remaining configuration submodes. Privilege EXEC mode also includes high-level testing commands, such as **debug**, and commands that display potentially secure information.

To enter privileged EXEC mode from EXEC mode, use the **enable** command and enter your password; the prompt changes to the ATM switch router's host name followed by the pound sign (#):

```
Switch> enable
Password:
Switch#
```

To exit from privileged EXEC mode back to EXEC mode, use the **disable** command.

```
Switch# disable
Switch>
```

The system administrator uses the **enable password** global configuration command to set the password, which is case sensitive. If an enable password has not been set, privileged EXEC mode can only be accessed from the console.

ROM Monitor Mode

ROM monitor mode provides access to a basic system kernel, from which you can boot the ATM switch router or perform diagnostic tests. If a valid system image is not found, or if the configuration file is corrupted, the system might enter ROM monitor mode. The ROM monitor prompt is the angle bracket:

```
>
```

You can also enter ROM monitor mode by intentionally interrupting the boot sequence with the **Break** key during loading. For a description of this process, refer to the *Configuration Fundamentals Configuration Guide*.

To return to EXEC mode from ROM monitor mode, use the **continue** command:

```
> continue
Switch>
```

Global Configuration Mode

Global configuration mode provides access to commands that apply to the entire system. From global configuration mode you can also enter the other configuration modes described in the following subsections.

To enter global configuration mode from privileged EXEC mode, enter the **configure** command and specify the source of the configuration commands at the prompt; the prompt changes to the ATM switch router's hostname followed by (config)#:

```
Switch# configure
Configuring from terminal, memory, or network [terminal]? <CR>
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
```

You can specify either the terminal, nonvolatile memory (NVRAM), or a file stored on a network server as the source of configuration commands. For more information, see Chapter 26, "Managing Configuration Files, System Images, and Functional Images." The default is to enter commands from the terminal console.

As a shortcut for accessing the terminal method of configuration, enter the following:

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
```

To exit global configuration command mode and return to privileged EXEC mode, use the **exit** or **end** command, or press **Ctrl-Z**:

```
Switch(config)# end
Switch#
```

Interface Configuration Mode

Interface configuration mode provides access to commands that apply on a per-interface basis. These commands modify the operation of an interface such as an ATM, Ethernet, or asynchronous port.

To enter interface configuration mode from global configuration mode, use the **interface** command with a keyword indicating the interface type, followed by an interface number; the prompt changes to the ATM switch router's hostname followed by (config-if)#:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)#
```

To exit interface configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-if)# exit
Switch(config)#
```

To exit interface configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-if)# end
Switch#
```

Interface Addressing Formats (Catalyst 8540)

In the ATM switch router chassis, you specify interfaces in slots 0 through 3 and 9 through 12 using the *card/subcard/port* format. Slots 4 and 8 each contain a CPU (multiservice route processor). Because the configurations on the primary and secondary route processors are automatically synchronized, they are configured via a single network interface, specified as **atm0** or **ethernet0**. There is no need to configure the secondary separately from the primary, but some show commands allow you to display information about the secondary route processor; in these cases, you specify the interface as **atm-sec0** or **ethernet-sec0**. Slots 5 through 7 contain the switch processors, which have no interfaces. Table 2-3 summarizes this addressing scheme, assuming that slot 4 is the primary route processor and slot 8 is the secondary route processor.

Table 2-3 Interface Addressing Formats (Catalyst 8540)

Slot	Addressing Format
0	*card/subcard/port*
1	*card/subcard/port*
2	*card/subcard/port*

Table 2-3 Interface Addressing Formats (Catalyst 8540) (continued)

Slot	Addressing Format
3	*card/subcard/port*
4	**atm0** or **ethernet0**
5	-
6	-
7	-
8	**atm-sec0** or **ethernet-sec0**
9	*card/subcard/port*
10	*card/subcard/port*
11	*card/subcard/port*
12	*card/subcard/port*

The following example shows how to enter interface configuration mode to configure the Ethernet interface on the CPU:

```
Switch(config)# interface ethernet0
Switch(config-if)#
```

CPU Interface Address Format (Catalyst 8510 MSR and LightStream 1010)

With this release of the ATM switch router software, addressing the interface on the processor (CPU) has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0.

The following example shows how to enter interface configuration mode to configure the Ethernet interface on the processor:

```
Switch(config)# interface ethernet0
Switch(config-if)#
```

Note The old formats (atm 2/0/0 and ethernet 2/0/0) are still supported in this release.

Interface Range Configuration Mode

Interface range configuration mode provides access to commands that apply to a range of interfaces. These commands modify the operation of an interface such as an ATM, Ethernet, or asynchronous port.

To enter interface range configuration mode from global configuration mode, use the **interface range** command with a range of interfaces to configure; the prompt changes to the ATM switch router hostname followed by (config-if)#:

```
Switch(config)# interface range atm 1/1/0-3
Switch(config-if)#
```

To exit interface range configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-if)# exit
Switch(config)#
```

To exit interface range configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-if)# end
Switch#
```

Subinterface Configuration Mode

Subinterface configuration mode allows access to commands that affect logical interfaces, also called subinterfaces. Subinterfaces are used, for example, to configure multiple VP tunnels on a single interface.

To enter subinterface configuration command mode from global configuration or interface configuration mode, use the **interface** command with a keyword indicating the interface type, followed by an interface and subinterface number; the prompt changes to the ATM switch router's hostname followed by (config-subif)#:

```
Switch(config)# interface atm 0/0/0.99
Switch(config-subif)#
```

To exit subinterface configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-subif)# exit
Switch(config)#
```

To exit interface configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-subif)# end
Switch#
```

Line Configuration Mode (Catalyst 8540 MSR)

Line configuration mode on the Catalyst 8540 MSR provides access to commands that modify the operation of individual terminal lines. These commands are used to configure the console, and vty connections, set up modem connections, and so on.

To enter line configuration mode from global configuration mode, use the **line** command followed by a line type (**console** or **vty**) and a line number or range; the prompt changes to the ATM switch router's hostname followed by (config-line)#:

```
Switch(config)# line vty 0
Switch(config-line)#
```

For detailed line configuration instructions, refer to the *Configuration Fundamentals Configuration Guide*.

To exit line configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-line)# exit
Switch(config)#
```

To exit line configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-line)# end
Switch#
```

Line Configuration Mode (Catalyst 8510 MSR and LightStream 1010)

Line configuration mode on the Catalyst 8510 MSR and LightStream 1010 ATM switch router provides access to commands that modify the operation of individual terminal lines. These commands are used to configure the console, auxiliary, and vty connections, set up modem connections, and so on.

To enter line configuration mode from global configuration mode, use the **line** command followed by a line type (**aux**, **console**, or **vty**) and a line number or range; the prompt changes to the ATM switch router's hostname followed by (config-line)#:

```
Switch(config)# line vty 0
Switch(config-line)#
```

For detailed line configuration instructions, refer to the *Configuration Fundamentals Configuration Guide*.

To exit line configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-line)# exit
Switch(config)#
```

To exit line configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-line)# end
Switch#
```

Map-List Configuration Mode

Map-list configuration mode provides access to commands used to statically map protocol addresses of remote hosts or switches to permanent virtual connections (PVCs) or switched virtual connections (SVCs).

To enter map-list configuration mode from global configuration mode, use the **map-list** command followed by a map-list name to configure; the prompt changes to the ATM switch router's hostname followed by (config-map-list)#:

```
Switch(config)# map-list newlist
Switch(config-map-list)#
```

You can also use the **map-list** command to enter map-list configuration mode directly from map-class configuration mode, without first returning to global configuration mode:

```
Switch(config-map-class)# map-list newlist
Switch(config-map-list)#
```

To exit map-list configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-map-list)# exit
Switch(config)#
```

To exit map-list configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-map-list)# end
Switch#
```

Map-Class Configuration Mode

Map-class configuration mode provides access to command used to define the traffic parameters when specifying a request for a switched virtual channel (SVC).

To enter map-class configuration mode from global configuration mode, enter the **map-class** command followed by a class name to configure; the prompt changes to the ATM switch router's hostname followed by (config-map-class)#:

```
Switch(config)# map-class atm newclass
Switch(config-map-class)#
```

You can also use the **map-class** command to enter map-class configuration mode directly from map-list configuration mode, without first returning to global configuration mode:

```
Switch(config-map-list)# map-class atm newclass
Switch(config-map-class)#
```

To exit map-class configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-map-class)# exit
Switch(config)#
```

To exit map-class configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-map-class)# end
Switch#
```

ATM Router Configuration Mode

ATM router configuration mode provides access to commands used to configure Private Network-Network Interface (PNNI) routing.

To enter ATM router configuration mode from global configuration mode, use the **atm router pnni** command; the prompt changes to the ATM switch router's hostname followed by (config-atm-router)#:

```
Switch(config)# atm router pnni
Switch(config-atm-router)#
```

To exit ATM router configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-atm-router)# exit
Switch(config)#
```

To exit ATM router configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-atm-router)# end
Switch#
```

For detailed information on configuring PNNI routing, see Chapter 11, "Configuring ATM Routing and PNNI."

PNNI Node Configuration Mode

The PNNI node configuration mode is a submode of ATM router configuration mode and provides access to commands you use to configure PNNI nodes on the ATM switch router.

To enter PNNI node configuration mode from ATM router configuration mode, use the **node** command followed by a node index; the prompt changes to the ATM switch router's hostname followed by (config-pnni-node)#:

```
Switch(config-atm-router)# node 1
Switch(config-pnni-node)#
```

To exit PNNI node configuration mode and return to ATM router configuration mode, use the **exit** command:

```
Switch(config-pnni-node)# exit
Switch(config-atm-router)#
```

To exit PNNI node configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-pnni-node)# end
Switch#
```

For detailed information on configuring PNNI nodes, see Chapter 11, "Configuring ATM Routing and PNNI."

PNNI Explicit Path Configuration Mode

The PNNI explicit path configuration mode provides access to commands used to manually configure fully specified or partially specified paths for routing soft permanent virtual channel (soft PVC) and soft permanent virtual path (soft PVP) connections.

To enter the PNNI explicit path configuration mode from global configuration mode, use the **atm pnni explicit-path** command followed by an explicit path name or path-id number; the prompt changes to the ATM switch router's hostname followed by (cfg-pnni-expl-path)#:

```
Switch(config)# atm pnni explicit-path name newexplicit-path
Switch(cfg-pnni-expl-path)#
```

To exit PNNI explicit path configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(cfg-pnni-expl-path)# exit
Switch(config)#
```

To exit PNNI explicit path configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(cfg-pnni-expl-path)# end
Switch#
```

For detailed information on configuring PNNI explicit paths, see Chapter 10, "Configuring ATM Routing and PNNI."

ATM Accounting File Configuration Mode

ATM accounting file configuration mode provides access to commands used to configure a file for accounting and billing of virtual circuits (VCs).

To enter ATM accounting file configuration mode from global configuration mode, use the **atm accounting file** command followed by an accounting filename; the prompt changes to the ATM switch router hostname followed by (config-acct-file)#:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)#
```

To exit ATM accounting file configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-acct-file)# exit
Switch(config)#
```

To exit ATM accounting file configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-acct-file)# end
Switch#
```

For detailed information on configuring ATM accounting, see Chapter 15, "Configuring ATM Accounting, RMON, and SNMP."

ATM Accounting Selection Configuration Mode

ATM accounting selection configuration mode provides access to commands used to specify the connection data to be gathered from the ATM switch router.

To enter ATM accounting selection configuration mode, use the **atm accounting selection** command and specify an accounting selection index; the prompt changes to the ATM switch router's hostname followed by (config-acct-sel)#:

```
Switch(config)# atm accounting selection 1
Switch(config-acct-sel)#
```

To exit ATM accounting selection configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-acct-sel)# exit
Switch(config)#
```

To exit ATM accounting selection configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-acct-sel)# end
Switch#
```

For detailed information on configuring ATM accounting selections, see Chapter 15, "Configuring ATM Accounting, RMON, and SNMP."

LANE Configuration Server Database Configuration Mode

LAN emulation (LANE) configuration server database configuration mode provides access to commands used to define the LANE configuration server database.

To enter LANE configuration server database configuration mode from global configuration mode, use the **lane database** command and specify a database name; the prompt changes to the ATM switch router's hostname followed by (lane-config-database)#:

```
Switch(config)# lane database lecsdb
Switch(lane-config-database)#
```

To exit LANE configuration server database configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(lane-config-database)# exit
Switch(config)#
```

To exit LANE configuration server database configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(lane-config-database)# end
Switch#
```

For detailed information on configuring the LAN emulation configuration server database, see Chapter 14, "Configuring LAN Emulation."

ATM E.164 Translation Table Configuration Mode

ATM E.164 translation table configuration mode provides access to commands used to configure the translation table that maps native E.164 format addresses to ATM end system (AESA) format addresses.

To enter ATM E.164 translation table configuration mode from global configuration mode, use the **atm e164 translation-table** command; the prompt changes to the ATM switch router's hostname followed by (config-atm-e164)#:

```
Switch(config)# atm e164 translation-table
Switch(config-atm-e164)
```

To exit ATM E.164 translation table configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-atm-e164)# exit
Switch(config)#
```

To exit ATM E.164 translation table configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-atm-e164)# end
Switch#
```

For detailed information on configuring E.164 addresses, see the Configuring E.164 Addresses section in Chapter 17, "Configuring Signalling Features."

ATM Signalling Diagnostics Configuration Mode

ATM signalling diagnostics configuration mode provides access to commands used to configure the signalling diagnostics table.

To enter ATM signalling diagnostics configuration mode from global configuration mode, use the **atm signalling diagnostics** command and specify an index for the filter table; the prompt changes to the ATM switch router's hostname followed by (cfg-atmsig-diag):

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)
```

To exit ATM signalling diagnostics configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(cfg-atmsig-diag)# exit
Switch(config)#
```

To exit ATM signalling diagnostics configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(cfg-atmsig-diag)# end
Switch#
```

For detailed information on configuring signalling diagnostics, see the Configuring Signalling Diagnostics Tables section in Chapter 17, "Configuring Signalling Features."

Controller Configuration Mode

Controller configuration mode provides access to commands used to configure physical and logical parameters of a channelized interface.

To enter ATM controller configuration mode from global configuration mode, use the **controller** command with a channel type and interface:

```
Switch(config)# controller e1 1/0/0
Switch(config-controller)#
```

To exit ATM controller configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-controller)# exit
Switch(config)#
```

To exit ATM controller configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-controller)# end
Switch#
```

For detailed information on configuring channel groups on a Frame Relay/FUNI interface, see Chapter 20, "Configuring Frame Relay to ATM Interworking Port Adapter Interfaces."

Redundancy Configuration Mode (Catalyst 8540 MSR)

Redundancy configuration mode provides access to commands used to configure system redundancy and EHSA operation.

To enter redundancy configuration mode from global configuration mode, use the **redundancy** command; the prompt changes to the ATM switch router's hostname followed by (config-r):

```
Switch(config)# redundancy
Switch(config-r)#
```

To exit ATM redundancy configuration mode and return to global configuration mode, use the **exit** command:

```
Switch(config-r)# exit
Switch(config)#
```

To exit ATM redundancy configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-r)# end
Switch#
```

For detailed information on configuring system redundancy, see the Testing the Configuration section in Chapter 3, "Initially Configuring the ATM Switch Router."

Main CPU Configuration Mode (Catalyst 8540 MSR)

Main CPU configuration mode provides access to commands used to synchronize the configuration of the primary and secondary route processors.

To enter main CPU configuration mode from redundancy configuration mode, use the **main-cpu** command; the prompt changes to the ATM switch router's hostname followed by (config-r-mc):

```
Switch(config-r)# main-cpu
Switch(config-r-mc)#
```

To exit ATM main CPU configuration mode and return to redundancy configuration mode, use the **exit** command:

```
Switch(config-r-mc)# exit
Switch(config-r)#
```

To exit ATM main cpu configuration mode and return to privileged EXEC mode, use the **end** command or press **Ctrl-Z**:

```
Switch(config-r-mc)# end
Switch#
```

For detailed information on synchronizing configurations, see the Testing the Configuration section in Chapter 3, "Initially Configuring the ATM Switch Router."

Additional Cisco IOS CLI Features

Because the ATM switch router's operating system is based on Cisco IOS software, its interface provides a number of features that help you use the CLI with greater flexibility, ease, and power. These features includes the following:

- Context-sensitive help—allows you to obtain a list of commands available for each command mode or a list of available options for a specific command by entering a question mark (**?**).
- Command history—records a history of commands, allowing you to recall previously entered long or complex commands.
- Editing—provides the ability to move around the command line, cut and paste entries, control scrolling, create keyboard macros, and so on.

For information on using these and other features of Cisco IOS software, refer to the *Configuration Fundamentals Configuration Guide*.

About Embedded CiscoView

Embedded CiscoView network management system provides a web-based interface for the Catalyst 8540, Catalyst 8510 and LightStream 1010. Embedded CiscoView uses HTTP and SNMP to provide graphical representations of the system and provide GUI-based management and configuration facilities. You can download the Java Archive (JAR) files for Embedded CiscoView at the following URL: http://www.cisco.com/kobayashi/sw-center/netmgmt/ciscoview/embed-cview-planner.shtml

Installing and Configuring Embedded CiscoView

To install and configure Embedded CiscoView on the Catalyst 8540, Catalyst 8510 and LightStream 1010, perform the following steps:

	Command	Purpose
Step 1	Switch# **dir slot***n***:**	Shows the contents of the CiscoView directory. If you are installing Embedded CiscoView for the first time, or if the CiscoView directory is empty, skip to Step 4.
Step 2	Switch# **delete slot***n***:cv/***	Removes existing files from the CiscoView directory.
Step 3	Switch# **squeeze slot***n***:**	Recovers the space in the file system.
Step 4	Switch# **archive tar /xtract tftp://** *ip address of tftp server***/** **ciscoview.tar slot***n***:cv**	Extracts the CiscoView files from the tar file on the TFTP server to the CiscoView directory.
Step 5	Switch# **dir slot***n***:**	Displays the file in Flash memory. Repeat Step 1 and Step 5 for the file system (**sby-slot***n***:**) on the standby processor.
Step 6	Switch# **configure terminal** Switch(config)#	Enters global configuration mode.

	Command	Purpose
Step 7	Switch(config)# **ip http server**	Enables the HTTP web server.
Step 8	Switch(config)# **snmp-server** *server community string* **RO|RW**	Enables the SNMP server and passwords for read-only operation or read/write operation.

Note The flash devices for installing and configuring Embedded Ciscoview are supported on slot 0, slot 1, disk 0, and disk 1.

Note The default password for accessing the device web page is the enable password of the device.

Note Use the NME IP address to access theCatalyst 8540, Catalyst 8510 and LightStream 1010 from a web browser.

Example

The following example shows how to update the CiscoView files on your Catalyst 8540, Catalyst 8510 and LightStream 1010:

```
Switch# dir slot0:
Directory of slot0:/

    1  -rw-     2276396   Apr 30 2001 17:48:07 Cat8500-i-mz.121
    2  -rw-     1251840   May 23 2001 14:03:35 ciscoview.tar
    3  -rw-        8861   May 23 2001 14:26:05  cv/Cat8500-4.0.html
    4  -rw-     1183238   May 23 2001 14:26:06  cv/Cat8500-4.0.sgz
    5  -rw-        3704   May 23 2001 14:27:55  cv/Cat8500-4.0_ace.html
    6  -rw-         401   May 23 2001 14:27:55  cv/Cat8500-4.0_error.html
    7  -rw-       17003   May 23 2001 14:27:55  cv/Cat8500-4.0_jks.jar
    8  -rw-       17497   May 23 2001 14:27:57  cv/Cat8500-4.0_nos.jar
    9  -rw-        8861   May 23 2001 14:27:59  cv/applet.html
   10  -rw-         529   May 23 2001 14:28:00  cv/cisco.x509
   11  -rw-        2523   May 23 2001 14:28:00  cv/identitydb.obj

16384000 bytes total (1287752 bytes free)

Switch# delete slot0:cv/*
Delete filename [cv/*]?
Delete slot0:cv/Cat8500-1.0.html? [confirm]
Delete slot0:cv/Cat8500-1.0.sgz? [confirm]
Delete slot0:cv/Cat8500-1.0_ace.html? [confirm]
Delete slot0:cv/Cat8500-1.0_error.html? [confirm]
Delete slot0:cv/Cat8500-1.0_jks.jar? [confirm]
Delete slot0:cv/Cat8500-1.0_nos.jar? [confirm]
Delete slot0:cv/applet.html? [confirm]
Delete slot0:cv/cisco.x509? [confirm]
Delete slot0:cv/identitydb.obj? [confirm]

Switch# squeeze slot0:
All deleted files will be removed. Continue? [confirm]
Squeeze operation may take a while. Continue? [confirm]

Squeeze of slot0 complete

Switch# archive tar /xtract tftp://20.1.1.1/ciscoview.tar slot0:cv
```

```
Loading ciscoview.tar from 20.1.1.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!.!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 1251840/2503680 bytes]

1251840 bytes copied in 109.848 secs (11484 bytes/sec)

Switch# dir slot0:
Directory of slot0:/

    1  -rw-     2276396   Jun 23 2001 17:48:07 Cat8500-i-mz.121
    2  -rw-     1251840   Jun 23 2001 14:03:35 ciscoview.tar
    3  -rw-        8861   Jun 23 2001 14:26:05  cv/Cat8500-4.0.html
    4  -rw-     1183238   Jun 23 2001 14:26:06  cv/Cat8500-4.0.sgz
    5  -rw-        3704   Jun 23 2001 14:27:55  cv/Cat8500-4.0_ace.html
    6  -rw-         401   Jun 23 2001 14:27:55  cv/Cat8500-4.0_error.html
    7  -rw-       17003   Jun 23 2001 14:27:55  cv/Cat8500-4.0_jks.jar
    8  -rw-       17497   Jun 23 2001 14:27:57  cv/Cat8500-4.0_nos.jar
    9  -rw-        8861   Jun 23 2001 14:27:59  cv/applet.html
   10  -rw-         529   Jun 23 2001 14:28:00  cv/cisco.x509
   11  -rw-        2523   Jun 23 2001 14:28:00  cv/identitydb.obj

Switch# delete sec-slot0:cv/*
Delete filename [cv/*]?
Delete slot0:cv/Cat8500-4.0.html? [confirm]
Delete slot0:cv/Cat8500-4.0.sgz? [confirm]
Delete slot0:cv/Cat8500-4.0_ace.html? [confirm]
Delete slot0:cv/Cat8500-4.0_error.html? [confirm]
Delete slot0:cv/Cat8500-4.0_jks.jar? [confirm]
Delete slot0:cv/Cat8500-4.0_nos.jar? [confirm]
Delete slot0:cv/applet.html? [confirm]
Delete slot0:cv/cisco.x509? [confirm]
Delete slot0:cv/identitydb.obj? [confirm]
Switch# squeeze sec-slot0:
All deleted files will be removed. Continue? [confirm]
Squeeze operation may take a while. Continue? [confirm]

Squeeze of sec-slot0 complete
Switch# archive tar /xtract tftp://20.1.1.1/ciscoview.tar slot0:cv
0): !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!.!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 1251840/2503680 bytes]

1251840 bytes copied in 109.848 secs (11484 bytes/sec)
Switch# dir sec-slot0:
Directory of slot0:/

    1  -rw-     2276396   Jun 23 2001 17:48:07 Cat8500-i-mz.121
    2  -rw-     1251840   Jun 23 2001 14:03:35 ciscoview.tar
    3  -rw-        8861   Jun 23 2001 14:26:05  cv/Cat8500-4.0.html
    4  -rw-     1183238   Jun 23 2001 14:26:06  cv/Cat8500-4.0.sgz
    5  -rw-        3704   Jun 23 2001 14:27:55  cv/Cat8500-4.0_ace.html
    6  -rw-         401   Jun 23 2001 14:27:55  cv/Cat8500-4.0_error.html
    7  -rw-       17003   Jun 23 2001 14:27:55  cv/Cat8500-4.0_jks.jar
    8  -rw-       17497   Jun 23 2001 14:27:57  cv/Cat8500-4.0_nos.jar
    9  -rw-        8861   Jun 23 2001 14:27:59  cv/applet.html
   10  -rw-         529   Jun 23 2001 14:28:00  cv/cisco.x509
   11  -rw-        2523   Jun 23 2001 14:28:00  cv/identitydb.obj

Switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch#(config)#ip http server
Switch#(config)#snmp-server community public RO
Switch#(config)#snmp-server community private RW
Switch#(config)#
```

Displaying Embedded CiscoView Information

To display the Embedded CiscoView information, use the following EXEC commands:

Command	Purpose
show ciscoview package	Displays information about the Embedded CiscoView files in the Flash PC Card.
show ciscoview version	Displays the Embedded CiscoView version.

Example

The following examples show how to display the Embedded CiscoView information:

```
8510MSR# show ciscoview package
File source:slot1:
CVFILE                          SIZE(in bytes)
------------------------------------------------
Cat8500-4.0.sgz                 1930848
Cat8500-4.0_ace.html            3704
Cat8500-4.0_error.html          401
Cat8500-4.0_jks.jar             15312
Cat8500-4.0_nos.jar             15936
cisco.x509                       529
identitydb.obj                   2523
applet.html                      8039

8510MSR# show ciscoview version
Engine Version: 5.3 ADP Device: Cat8500 ADP Version: 4.0 ADK: 38
```

CHAPTER 3

Initially Configuring the ATM Switch Router

This chapter discusses specific steps used to initially configure the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For conceptual and background information, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Methods for Configuring the ATM Switch Router

The ATM switch router defaults to a working configuration suitable for most networks. However, you might need to customize the configuration for your network.

Note If your Telnet station or SNMP network management workstation is on a different network from the switch, you must add a static routing table entry to the routing table. See Chapter 11, "Configuring ATM Routing and PNNI."

Terminal Line Configuration (Catalyst 8540 MSR)

The Catalyst 8540 MSR has a console terminal line that might require configuration. For line configuration, you must first set up the line for the terminal or the asynchronous device attached to it. For a complete description of configuration tasks and commands used to set up your terminal line and settings, refer to the *Configuration Fundamentals Configuration Guide* and *Dial Solutions Configuration Guide*.

You can connect a modem to the console port. The following settings on the modem are required:

- Enable auto answer mode
- Suppress result codes

You can configure your modem by setting the DIP switches on the modem or by connecting the modem to terminal equipment. Refer to the user manual provided with your modem for the correct configuration information.

Note Because there are no hardware flow control signals available on the console port, the console port terminal characteristics should match the modem settings.

Terminal Line Configuration (Catalyst 8510 MSR and LightStream 1010)

The ATM switch has two types of terminal lines: a console line and an auxiliary line. For line configuration, you must first set up the lines for the terminals or other asynchronous devices attached to them. For a complete description of configuration tasks and commands used to set up your lines, modems, and terminal settings, refer to the *Configuration Fundamentals Configuration Guide* and *Dial Solutions Configuration Guide*.

Configuration Prerequisites

Consider the following information you might need before you configure your ATM switch router:

- If you want to configure a BOOTP server to inform the switch of its Ethernet IP address and mask, you need the Media Access Control (MAC) address of the Ethernet port.
- If you want to configure a new ATM address for the switch (an autoconfigured ATM address is assigned by Cisco), you need an ATM address assigned by your system administrator.
- If you are not using BOOTP, you need an IP address and a netmask address.

Verifying Software and Hardware Installed on the ATM Switch Router

When you first power up your console and ATM switch router, a screen similar to the following from a Catalyst 8540 MSR appears:

```
Restricted Rights Legend

Use, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph
(c) of the Commercial Computer Software - Restricted
Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706



Cisco Internetwork Operating System Software
IOS (tm) PNNI Software (cat8540m-WP-M), Version 12.0(4a)W5(10.44),  INTERIM TEST
 SOFTWARE
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Tue 17-Aug-99 03:18 by
Image text-base: 0x60010930, data-base: 0x60936000



CUBI Driver subsystem initializing ...

primary interrupt reg read FFC00
secondary interrupt reg read EA800
*** this cpu is the primary
Enabling the MS timer



Switch Fabric Driver subsystem initializing ...

found
 smid=0
 smid=2
 smid=4
 smid=6
 smid=1
 smid=3
 smid=5
 smid=7
in cfc_init

... DONE
```

```
IDPROM in slot 0 not properly programmed
cisco C8540MSR (R5000) processor with 262144K bytes of memory.
R5000 processor, Implementation 35, Revision 2.1 (512KB Level 2 Cache)
Last reset from power-on
3 Ethernet/IEEE 802.3 interface(s)
11 ATM network interface(s)
507K bytes of non-volatile configuration memory.

20480K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
8192K bytes of Flash PCMCIA card at slot 1 (Sector size 128K).
8192K bytes of Flash internal SIMM (Sector size 256K).
%ENABLING INTERFACES.PLEASE WAIT...
%Secondary CPU has not booted IOS


Press RETURN to get started!
```

Note If an rommon> prompt appears, your switch requires a manual boot to recover. Refer to the *Configuration Fundamentals Configuration Guide* for instructions on manually booting from Flash memory.

Configuring the BOOTP Server

The BOOTP protocol automatically assigns an Ethernet IP address by adding the MAC and IP addresses of the Ethernet port to the BOOTP server configuration file. When the switch boots, it automatically retrieves the IP address from the BOOTP server.

The switch performs a BOOTP request *only* if the current IP address is set to 0.0.0.0. (This is the default for a new switch or a switch that has had its startup-config file cleared using the **erase** command.)

To allow your ATM switch router to retrieve its IP address from a BOOTP server, you must first determine the MAC address of the switch and add that MAC address to the BOOTP configuration file on the BOOTP server. The following steps provide an example of creating a BOOTP server configuration file:

	Command	Purpose
Step 1	—	Installs the BOOTP server code on the workstation, if it is not already installed.
Step 2	—	Determines the MAC address from the label on the chassis.
Step 3	—	Adds an entry in the BOOTP configuration file (usually */usr/etc/bootptab*) for each switch. Press **Return** after each entry to create a blank line between each entry. See the example BOOTP configuration file that follows.
Step 4	Switch# **reload**	Restarts the ATM switch router to automatically request the IP address from the BOOTP server.

Example

The following example BOOTP configuration file shows the added entry:

```
# /etc/bootptab: database for bootp server (/etc/bootpd)
#
# Blank lines and lines beginning with '#' are ignored.
#
# Legend:
#
#       first field -- hostname
#                       (may be full domain name and probably should be)
#
#       hd -- home directory
#       bf -- bootfile
#       cs -- cookie servers
#       ds -- domain name servers
#       gw -- gateways
#       ha -- hardware address
#       ht -- hardware type
#       im -- impress servers
#       ip -- host IP address
#       lg -- log servers
#       lp -- LPR servers
#       ns -- IEN-116 name servers
#       rl -- resource location protocol servers
#       sm -- subnet mask
#       tc -- template host (points to similar host entry)
#       to -- time offset (seconds)
#       ts -- time servers
#
<information deleted>
#
#########################################################################
# Start of individual host entries
#########################################################################
➔ Switch:         tc=netcisco0:   ha=0000.0ca7.ce00:      ip=172.31.7.97:
dross:          tc=netcisco0:   ha=00000c000139:        ip=172.31.7.26:

<information deleted>
```

Configuring the ATM Address

The ATM switch router ships with a preconfigured ATM address. The Integrated Local Management Interface (ILMI) protocol uses the first 13 bytes of this address as the switch prefix that it registers with end systems. Autoconfiguration also allows the ATM switch router to establish itself as a node in a single-level Private Network-Network Interface (PNNI) routing domain.

Note If you chose to manually change any ATM address, it is important to maintain the uniqueness of the address across large networks. Refer to the *Guide to ATM Technology* for PNNI address considerations and for information on obtaining registered ATM addresses.

For a description of the autoconfigured ATM address and considerations when assigning a new address, refer to the *Guide to ATM Technology*.

Manually Setting the ATM Address

To configure a new ATM address that replaces the previous ATM address when running IISP software only, see Chapter 11, “Configuring ATM Routing and PNNI.”.

To configure a new ATM address that replaces the previous ATM address and generates a new PNNI node ID and peer group ID, see Chapter 11, “Configuring ATM Routing and PNNI.”

Modifying the Physical Layer Configuration of an ATM Interface

Each of the ATM switch router’s physical interfaces has a default configuration, listed in Chapter 18, “Configuring Interfaces.” You can accept the defaults, or you can override them by reconfiguring the physical interface.

The following example describes modifying an OC-3c interface from the default settings to the following:

- Disable scrambling cell-payload.
- Disable scrambling STS-streaming.
- Change Synchronous Optical Network (SONET) mode of operation from Synchronous Time Stamp level 3c (STS-3c) mode to Synchronous Transfer Module level 1 (STM-1).

To change the configuration of the example interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **no scrambling cell-payload**	Disables cell-payload scrambling.
Step 3	Switch(config-if)# **no scrambling sts-stream**	Disables STS-stream scrambling.
Step 4	Switch(config-if)# **sonet stm-1**	Configures SONET mode as SDH/STM-1.

Example

The following example shows how to disable cell-payload scrambling and STS-stream scrambling and changes the SONET mode of operation to Synchronous Digital Hierarchy/Synchronous Transfer Module 1 (SDH/STM-1) of OC-3c physical interface ATM 0/0/0:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# no scrambling cell-payload
Switch(config-if)# no scrambling sts-stream
Switch(config-if)# sonet stm-1
```

To change any of the other physical interface default configurations, refer to the commands in the *ATM Switch Router Command Reference* publication.

To display the physical interface configuration, use the following privileged EXEC commands:

Command	Purpose
show controllers atm *card/subcard/port*	Shows the physical layer configuration.
more system:running-config	Shows the physical layer scrambling configuration.

Examples

The following example demonstrates using the **show controllers** command to display the OC-3c physical interface configuration after modification of the defaults:

```
Switch# show controllers atm 0/0/0
IF Name: ATM0/0/0    Chip Base Address: A8808000
Port type: 155UTP    Port rate: 155 Mbps    Port medium: UTP
Port status:SECTION LOS    Loopback:None    Flags:8300
TX Led: Traffic Pattern    RX Led: Traffic Pattern  TX clock source:  network-derived
Framing mode:  stm-1
Cell payload scrambling off
Sts-stream scrambling off

<information deleted>
```

The following example displays the OC-3c physical layer scrambling configuration after modification of the defaults using the **more system:running-config** command:

```
Switch# more system:running-config
!
version XX.X
<information deleted>
!
interface ATM0/0/0
 no keepalive
 atm manual-well-known-vc
 atm access-group tod1 in
 atm pvc 0 35 rx-cttr 3 tx-cttr 3  interface  ATM0 0 any-vci  encap qsaal
 sonet stm-1
 no scrambling sts-stream
 no scrambling cell-payload
!
<information deleted>
```

Configuring the IP Interface

IP addresses can be configured on the multiservice route processor interfaces. Each IP address is configured for one of the following types of connections:

- Ethernet port—Can be configured either from the BOOTP server or by using the **ip address** command in interface configuration mode.
- Classical IP over ATM—See Chapter 13, "Configuring IP over ATM."
- LANE client—See Chapter 14, "Configuring LAN Emulation."
- Serial Line Internet Protocol/Point-to-Point Protocol (SLIP/PPP)—Refer to the *Dial Solutions Configuration Guide*.

Note These IP connections are used only for network management.

To configure the switch to communicate via the Ethernet interface, provide the IP address and subnet mask bits for the interface.

This section includes the following:

- Configuring IP Address and Subnet Mask Bits, page 3-8
- Testing the Ethernet Connection, page 3-9

Configuring IP Address and Subnet Mask Bits

Define subnet mask bits as a decimal number between 0 and 22 for Class A addresses, between 0 and 14 for Class B addresses, or between 0 and 6 for Class C addresses. Do not specify 1 as the number of bits for the subnet field. That specification is reserved by Internet conventions.

To configure the IP address, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface ethernet 0** Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Configures the IP and subnetwork address.

Note Since release 12.0(1a)W5(5b) of the ATM switch software, addressing the interface on the processor (CPU) has changed. The ATM interface is now called atm 0, and the Ethernet interface is now called ethernet 0. The old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

Example

The following example shows how to configure interface ethernet 0 with IP address 172.20.40.93 and subnetwork mask 255.255.255.0:

```
Switch(config)# interface ethernet 0
Switch(config-if)# ip address 172.20.40.93 255.255.255.0
```

Displaying the IP Address

To display the IP address configuration, use the following privileged EXEC commands:

Command	Purpose
show interfaces ethernet 0	Displays the Ethernet interface IP address.
more system:running-config	Shows the physical layer scrambling configuration.

Examples

The following example shows how to use the **show interfaces** command to display the IP address of interface ethernet 0:

```
Switch# show interfaces ethernet 0
Ethernet0 is up, line protocol is up
  Hardware is SonicT, address is 0040.0b0a.1080 (bia 0040.0b0a.1080)
  Internet address is 172.20.40.93/24
  <information deleted>
```

The following example uses the **more system:running-config** command to display the IP address of interface ethernet 0:

```
Switch# more system:running-config
!
version XX.X
<information deleted>
!
interface Ethernet0
 ip address 172.20.40.93 255.255.255.0
!
<information deleted>
```

Testing the Ethernet Connection

After you have configured the IP address(es) for the Ethernet interface, test for connectivity between the switch and a host. The host can reside anywhere in your network. To test for Ethernet connectivity, use the following EXEC command:

Command	Purpose
ping ip *ip-address*	Tests the configuration using the ping command. The ping command sends an echo request to the host specified in the command line.

The following example show how to test the Ethernet connectivity from the switch to a workstation with an IP address of 172.20.40.201:

```
Switch# ping ip 172.20.40.201

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.20.40.201, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
```

Configuring Network Clocking

This section describes network clocking configuration of the ATM switch router. Properly synchronized network clocking is important in the transmission of constant bit rate (CBR) and variable bit rate real time (VBR-RT) data. For an overview of network clocking and network clock configuration issues, refer to the chapter "Network Clock Synchronization" in the *Guide to ATM Technology*.

Network Clocking Features

Different types of network clock sources are available on the ATM switch router, both internal and external. Table 3-1 provides a summary of network clocking features.

Table 3-1 Network Clocking Feature Summary

Platform	Up/Down Detection	Loss of Synchronization Detection	Phase Adjustment Cutover	Stratum 3 Clock	BITS[1] Port	Clock Source Preference
Catalyst 8540 MSR with network clock module	Yes	Yes	Yes	Yes	Yes	Best
Catalyst 8510 MSR	Yes	Yes	Yes	No	No	Medium
LightStream 1010 with FC-PFQ	Yes	Yes	Yes	No	No	Medium
Catalyst 8540 MSR without network clock module	Yes	No	No	No	No	Poor
LightStream 1010 without FC-PFQ	Yes	No	No	No	No	Poor

1. BITS = Building Integrated Timing Supply

Configuring Network Clock Sources and Priorities (Catalyst 8540 MSR)

To configure the network clocking priorities and sources, use the following command in global configuration mode:

Command	Purpose
network-clock-select {*priority* {{**atm** | **cbr**} *card/subcard/port*} | **bits** {**0** | **1**} | **system**} | **bits** {**e1** | **t1**} | **revertive**	Configures the network clock priority.

Note Specifying the keyword **system** with the **network-clock-select command** selects the route processor reference clock (a stratum 4 clock source) or the network clock module (a stratum 3 clock source), if present.

Systems equipped with the network clock module can derive clocking from a Building Integrated Timing Supply (BITS) source. To specify the line type attached to the BITS ports on the network clock module and to assign a priority to a port, use the following commands in global configuration mode:

Command	Purpose
network-clock-select bits {**t1** | **e1**}	Selects the line type. This command applies to both BITS ports.
network-clock-select *priority* **bits** {**0** | **1**}	Selects the priority for a BITS port.

Examples

The following example shows how to configure the network clock priorities:

```
Switch(config)# network-clock-select 1 atm 0/0/0
Switch(config)# network-clock-select 2 atm 0/0/3
```

Note This configuration assumes that a full-width module, such as the 4-port OC-12c module, is being used to derive clocking. If port adapters inserted into carrier modules are used, the priority 1 and 2 source ports must be on different port adapters.

The following example shows how to configure the network clock to revert to the highest priority clock source after a failure and takeover by the source with the next lowest priority.

```
Switch(config)# network-clock-select revertive
```

Configuring Network Clock Sources and Priorities (Catalyst 8510 MSR and LightStream 1010)

To configure the network clocking priorities and sources, use the following command in global configuration mode:

Command	Purpose
network-clock-select {*priority* {{**atm** | **cbr**} *card/subcard/port*} | **system**} | **revertive**	Configures the network clock priority.

Note Specifying the keyword **system** with the **network-clock-select command** selects the route processor reference clock (a stratum 4 clock source).

Examples

The following example shows how to configure the network clock priorities:

```
Switch(config)# network-clock-select 1 atm 0/0/0
Switch(config)# network-clock-select 2 atm 0/0/3
```

The following example shows how to configure the network clock to revert to the highest priority clock source after a failure and takeover by the source with the next lowest priority.

```
Switch(config)# network-clock-select revertive
```

Configuring the Transmit Clocking Source

To configure where each interface receives its transmit clocking, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Configures the interface clock source.

Caution If the Network Clock Distribution Protocol (NCDP) is running on an interface, you should not override that port's clock source by configuring it to free-running or loop-timed. Doing so could cause synchronization problems, particularly in the case of loop-timed, which could cause a clocking loop to be formed on a link. See the Configuring Network Clocking with NCDP, page 3-13.

Example

The following example configures ATM interface 3/0/0 to receive its transmit clocking from a network-derived source:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# clock source network-derived
```

Displaying the Network Clocking Configuration

To show the switch's network clocking configuration, use the following privileged EXEC commands:

Command	Purpose
show network-clocks	Shows the network clocking configuration.
more system:running-config	Shows the interface clock source configuration.
show controllers [**atm** *card/subcard/port*]	Shows the interface controller status.

Examples

The following example shows the configured network clock sources on a Catalyst 8510 MSR or LightStream 1010:

```
Switch# show network-clocks
clock configuration is NON-Revertive
Priority 1 clock source: ATM1/0/0
Priority 2 clock source: ATM1/1/0
Priority 3 clock source: No clock
Priority 4 clock source: No clock
Priority 5 clock source: System clock
Current clock source:System clock, priority:5
```

Note A source listed as "No clock" indicates that no clock source configured at that priority.

The following example shows the switch clock source configuration with the network clock module installed:

```
Switch# show network-clocks
Network clocking information:
---------------------------------------
Source switchover mode:    revertive
Netclkd state:             Active
Source selection method:   provisioned
NCLKM hardware status:     installed & usable
NCLKM status:              software enabled
Primary   clock source:    ATM0/0/0
Secondary clock source:    not configured
Present   clock source:    NCLKM Stratum 3 osc (0)
```

The following example shows the clock source configuration stored in the running configuration:

```
Switch# more system:running-config
!
<information deleted>
!
network-clock-select revertive
network-clock-select 1 ATM0/0/0
<information deleted>
```

Configuring Network Clocking with NCDP

The Network Clock Distribution Protocol (NCDP) provides a means by which a network can synchronize automatically to a primary reference source (PRS). To do so, NCDP constructs and maintains a spanning network clock distribution tree. This tree structure is superimposed on the network nodes by the software, resulting in an efficient, synchronized network suitable for transport of traffic with inherent synchronization requirements, such as voice and video.

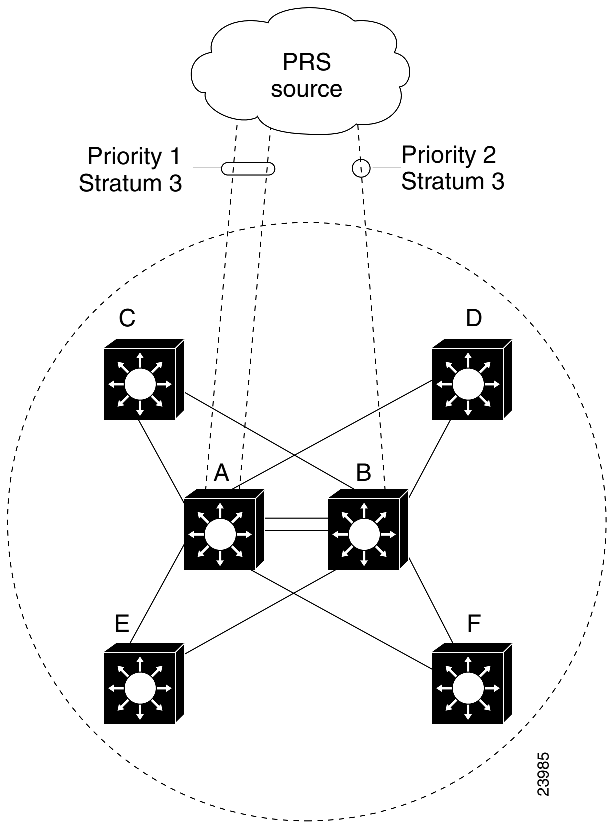
The following sections provide instructions for configuring NCDP. For a description of how NCDP works, refer to the *Guide to ATM Technology*.

Note The NCDP is intended for use on ATM switch routers equipped with FC-PFQ or with the network clock module.

NCDP Network Example

Figure 3-1 shows a network of six ATM switch routers with clocking derived from a stratum 3 PRS. Node A is configured to receive priority 1 clocking on two of its ports, while node B is configured to receive priority 2 clocking on one of its ports.

Figure 3-1 Network Configuration for NCDP



Enabling NCDP

To enable NCDP, use the following global configuration command for each node that you want to configure for NCDP:

Command	Purpose
ncdp	Enables NCDP.

Configuring Network Clock Sources and Priorities

You must specify the clocking sources, their priorities, and associated stratums used by NCDP in constructing the clock distribution tree. To do so, use the following command in global configuration mode:

Command	Purpose
ncdp source *priority* {{**atm** | **cbr**} *card/subcard/port stratum* | **bits**[1] {**0** | **1**} *stratum* | **system**}	Specifies a priority and source (stratum level or system) for this interface.

1. Allows you to specify a Building Integrated Timing Supply (BITS) source. This option is available only on the Catalyst 8540 MSR equipped with the network clock module.

If you do not configure a clock source, NCDP advertises its default source of network clock, which is its local oscillator; if no nodes in the network have a clock source configured, the tree is built so that it is rooted at the switch having the highest stratum oscillator (lowest numerical value) and lowest ATM address.

Example

The following example demonstrates configuring the network clock source, priority, and stratum on node A in Figure 3-1.

```
Switch(config)# ncdp source 1 atm 1/0/0 3
Switch(config)# ncdp source 1 atm 3/0/0 3
```

Configuring Optional NCDP Global Parameters

Optional NCDP parameters you can configure at the global level include the maximum number of hops between any two nodes, revertive behavior, and the values of the NCDP timers. To change any of these parameters from their defaults, use the following commands in global configuration mode:

Command	Purpose
ncdp max-diameter *hops*	Specifies the maximum network diameter for the protocol. The default maximum network diameter is 20.
ncdp revertive	Specifies the NCDP as revertive.
ncdp timers {**hello** | **hold**} *time-in-msec jitter-percent*	Specifies the values to be used by the NCDP timers.

When you specify a maximum diameter, you constrain the diameter of the spanning tree by specifying the maximum number of hops between any two nodes that participate in the protocol. Each node must be configured with the same maximum network diameter value for NCDP to operate correctly.

When you configure the NCDP as revertive, a clock source that is selected and then fails is selected again once it has become operational for a period of time. On the Catalyst 8510 MSR and LightStream 1010 platforms, if NCDP is configured to be revertive, a failed clocking source node after a switchover is restored to use after it has been functioning correctly for at least 1 minute. On the Catalyst 8540 MSR the failed source is restored after about 25 seconds. The network clock is, by default, configured as nonrevertive. Nonrevertive prevents a failed source from being selected again.

Example

The following example shows setting the maximum number of hops to 11 and enabling revertive behavior:

```
Switch(config)# ncdp max-diameter 11
Switch(config)# ncdp revertive
```

Configuring Optional NCDP Per-Interface Parameters

On a per-interface basis, you can enable or disable NCDP, specify the cost metric associated with the port, and change the control virtual circuit used to transport protocol messages between adjacent protocol entities. To change any of these parameters from their defaults, use the following commands in interface configuration mode:

Command	Purpose
ncdp admin-weight *weight*	Specifies the cost metric associated with the given port.
ncdp control-vc *vpi vci*	Specifies the VPI/VCI values to use for control VCs on the physical interface. The default is 0, 34. **Note** To change the control VC to a VPI other than 0, the VPI must exist on the physical interface.
no ncdp	Disables NCDP on the interface.

Example

The following example demonstrates setting the administrative weight on an interface:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# ncdp admin-weight 75
```

Displaying the NCDP Configuration

To display the NCDP configuration, use the following EXEC commands:

Command	Purpose
show ncdp path root	Displays the NCDP clock path from the switch to the root source.
show ncdp ports	Displays NCDP port information.
show ncdp sources	Displays NCDP clock sources configured on the switch.
show ncdp status	Displays NCDP status.
show ncdp timers	Displays NCDP timer information.

Example

The following example shows the NCDP status:

```
Switch# show ncdp status
 = ncdp switch information ==== enabled ==============
 non-revertive
 root clock source priority:      1
 root clock source stratum level: 4
 root clock source prs id:        255
 stratum level of root switch:    4
 clocking root address:           4700918100000000E0F75D040100E0F75D040100
 hop count:                       0
 root path cost:                  0
 root port:                       0
 max age:                         5
 hello time:                      500
 priority      of best source:    1
 stratum level of best source:    4
 prs id        of best source:    255
 switch stratum level:            4
 address:                         4700918100000000E0F75D040100E0F75D040100
 switch max age:                  5
 switch hello time:               500
 switch hold time:                500
 max diameter:                    5
 converged root count:            359375
 converged:                       1
 total timer events:              687271
 total queue events:              0
 rx config messages:              0
 tx config messages:              363716
 rx tcn messages:                 0
 tx tcn messages:                 0
 rx non-participant messages:     0
 rx unknown messages:             0

Switch#
```

Network Clock Services for CES Operations and CBR Traffic

Circuit emulation services-interworking functions (CES-IWF) and constant bit rate (CBR) traffic relate to a quality of service (QoS) classification defined by the ATM Forum for Class A (ATM adaptation layer 1 [AAL1]) traffic in ATM networks. In general, Class A traffic pertains to voice and video transmissions, which have particular clocking requirements. For details, refer to Chapter 19, "Configuring Circuit Emulation Services."

Configuring Network Routing

The default software image for the ATM switch router contains the Private Network-Network Interface (PNNI) routing protocol. The PNNI protocol provides the route dissemination mechanism for complete plug-and-play capability. The following section, "Configuring ATM Static Routes for IISP or PNNI," describes modifications that can be made to the default PNNI or Interim-Interswitch Signalling Protocol (IISP) routing configurations.

For routing protocol configuration information, refer to Chapter 10, "Configuring ILMI,"and Chapter 11, "Configuring ATM Routing and PNNI."

Configuring ATM Static Routes for IISP or PNNI

Static route configuration allows ATM call setup requests to be forwarded on a specific interface if the addresses match a configured address prefix. To configure a static route, use the following command in global configuration mode:

Command	Purpose
atm route *addr-prefx* **atm** *card/subcard/port*	Specifies a static route to a reachable address prefix.

Note An interface must be User-Network Interface (UNI) or Interim Interswitch Signalling Protocol (IISP) to be configured with static route. Static routes configured as PNNI interfaces default as down.

The following example shows how to use the **atm route** command to configure the 13-byte peer group prefix = 47.0091.8100.567.0000.0ca7.ce01 at interface ATM 3/0/0:

```
Switch(config)# atm route 47.0091.8100.567.0000.0ca7.ce01 atm 3/0/0
Switch(config)#
```

Configuring System Information

Although not required, the system clock and hostname should be set as part of the initial system configuration. To set these system parameters, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **clock set** *hh:mm:ss day month year*	Sets the system clock.
Step 2	Switch# **configure terminal** Switch(config)#	Enters global configuration mode from the terminal.
Step 3	Switch(config)# **hostname** *name*	Sets the system name.

Examples

The following example shows how to configure the time, date, and month using the **clock set** command, enter global configuration mode, and assign a hostname.

```
Switch# clock set 15:01:00 17 October 1999
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# hostname Publications
Publications#
```

The following example shows how to confirm the clock setting using the **show clock** command:

```
Publications# show clock
*15:03:12.015 UTC Fri Oct 17 1999
```

Configuring Online Diagnostics (Catalyst 8540 MSR)

Online and insertion diagnostics detect and report hardware failures in the Catalyst 8540 MSR during system bootup and operation.

The online diagnostics on the Catalyst 8540 MSR provide the following types of tests:

- Access tests between the route processor and the switch processors, feature cards, port adapters, and interface modules
- Online insertion and removal (OIR) diagnostic tests
- Snake tests through the switch router to ensure connectivity between the ports

Note Online diagnostics tests only run on the primary route processor.

Access Test (Catalyst 8540 MSR)

The access tests ensure connectivity at a configurable interval between the primary route processor and the following:

- Active switch processors
- Standby switch processor, if it is present

- Feature cards
- Carrier modules
- ATM port adapters
- ATM and Layer 3 interface modules
- ATM router modules

When the access test detects a hardware failure, the system issues an error message to the console.

If the access test detects a hardware problem with an active switch processor, the standby switch processor, if it is present, automatically takes over and becomes an active switch processor. The system generates an SNMP trap when the switchover occurs.

Note The access test does not support the network clock module.

OIR Test (Catalyst 8540 MSR)

Online insertion and removal (OIR) tests check the functioning of the switch fabric and interfaces on a per-port basis. The switch router performs these tests when the system boots up and when you insert a port adapter or interface module into a slot. The OIR test sends a packet to the interface loopback and expects to receive it back within a certain time period. If the packet does not reach the port within the expected time period, or the route processor receives a corrupted packet, the system issues an error message to the console, generates an SNMP trap, and brings the port to an administrative down state.

Note The size of the packet used in the test is configurable.

The OIR tests support all ATM port adapters, all ATM interface modules, all ATM router modules, and all Layer 3 interface modules except the 8-port Gigabit Ethernet.

Snake Test (Catalyst 8540 MSR)

The snake test detects and reports port-to-port connectivity failures. The snake test establishes a connection across all the active ports in the switch router, originating and terminating at the primary route processor. The route processor establishes a connection by sending a packet to each port in turn, which then terminates at the route processor. If the packet does not reach the route processor within the expected time period, or the received packet is corrupted, further testing is performed to isolate and disable the port causing the problem.The size of the packet and frequency of the test are configurable to minimize the impact on system performance.

The snake test supports Enhanced ATM Router Module (also known as ARMII), all ATM interface modules and enhanced Gigabit Ethernet interface modules. It does not support ATM port adapters, ATM router module (also known as ARMI), 16-port 10/100 Fast Ethernet interface modules, 2-port Gigabit Ethernet interface modules, or 8-port Gigabit Ethernet interface modules.

Note The snake test does not support ATM port adapters because of a hardware limitation in the carrier module.

Configuring Online Diagnostics (Catalyst 8540 MSR)

To configure online diagnostics, use the following global configuration commands:

Command	Purpose
diag online	Enables all of the online diagnostic tests.
diag online access	Enables only the access diagnostic test.
diag online access freq [*seconds*]	Configures the frequency of the access diagnostic tests. The default frequency is every 10 seconds.
diag online oir	Enables only the OIR test.
diag online oir pktsize [*bytes*]	Specifies the packet size for the OIR test. The default size is 1000 bytes.
diag online snake	Enables only the snake test.
diag online snake timer [*seconds*]	Specifies the time interval for the snake test. The default interval is 60 seconds.
no diag online [**access** | **oir** | **snake**]	Disables the online diagnostic tests.
debug diag online [**access** | **oir** | **snake**]	Enables debugging of online diagnostic tests.
no debug diag online [**access** | **oir** | **snake**]	Disables debugging of online diagnostic tests.

Examples

The following example shows how to enable all online diagnostic tests:

```
Switch(config)# diag online
 ONLINE-DIAG: Enabling all Online Diagnostics tests
```

The following example shows how to change the frequency of the access test to 20 seconds:

```
Switch(config)# diag online access freq 20
ONLINE-DIAG: Online Access Test Frequency set to 20 sec
```

Displaying the Online Diagnostics Configuration and Results (Catalyst 8540 MSR)

To display the online diagnostics configuration and results, use the following EXEC command:

Command	Purpose
show diag online [**details** | **status**] [**access** | **oir** | **snake**]	Displays information about the online diagnostics test configuration and the test results.

Examples

The following example shows how to display detailed access test configuration and results:

```
Switch# show diag online details access
======== Online Access Test Details ========
Current Test Status : Test is Enabled
Current Frequency of Access Test : 20 seconds

Slot Card-Type       Iteration    Success    Failure    Last Failure
---- ----------      ----------   -------    -------    ------------
 0/* Super Cam       42998        42998      0          ----
 0/0 8T1 IMA PAM     42998        42998      0          ----
 0/1 8E1 IMA PAM     42998        42998      0          ----
 2/* ARM PAM         42998        42998      0          ----
 3/* ETHERNET PAM    42998        42998      0          ----
 5/* Switch Card     42998        42998      0          ----
 5/0 Feature Card    42998        42998      0          ----
 7/* Switch Card     42998        42998      0          ----
 7/0 Feature Card    42998        42998      0          ----
 9/* OC48c PAM       42998        42998      0          ----
10/* OCM Board       42998        42998      0          ----
10/0 QUAD 622 Generi 42998        42998      0          ----
======== Online Access Test Details End ========
```

The following example shows how to display the status of the OIR test:

```
Switch# show diag online status oir
======== Online OIR Test Status ========
Current Test Status : Test is Enabled
-------- Bootup OIR status --------
Port     Card Type    Pkt Size  Result                   Test Time LOOP
_______ ___________ _________ ___________________  ______________ ____
00/0/00 8T1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/0/01 8T1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/0/02 8T1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/0/03 8T1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/1/00 8E1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/1/01 8E1 IMA PAM       300 OIR_SUCCESS                00:00:46  PIF
00/1/02 8E1 IMA PAM       300 OIR_SUCCESS                00:00:41  PIF
00/1/03 8E1 IMA PAM       300 OIR_SUCCESS                00:00:46  PIF

03/0/00 ETHERNET PA      1000 OIR_SUCCESS                00:01:54  PIF
03/0/01 ETHERNET PA      1000 OIR_SUCCESS                00:01:52  PIF
03/0/02 ETHERNET PA      1000 OIR_SUCCESS                00:01:50  PIF
03/0/03 ETHERNET PA      1000 OIR_SUCCESS                00:01:48  PIF
03/0/04 ETHERNET PA      1000 OIR_SUCCESS                00:01:55  PIF
03/0/05 ETHERNET PA      1000 OIR_SUCCESS                00:01:53  PIF
03/0/06 ETHERNET PA      1000 OIR_SUCCESS                00:01:51  PIF
03/0/07 ETHERNET PA      1000 OIR_SUCCESS                00:01:49  PIF
03/0/08 ETHERNET PA      1000 OIR_SUCCESS                00:02:02  PIF
03/0/09 ETHERNET PA      1000 OIR_SUCCESS                00:02:00  PIF
03/0/10 ETHERNET PA      1000 OIR_SUCCESS                00:01:58  PIF
03/0/11 ETHERNET PA      1000 OIR_SUCCESS                00:01:56  PIF
03/0/12 ETHERNET PA      1000 OIR_SUCCESS                00:02:03  PIF
03/0/13 ETHERNET PA      1000 OIR_SUCCESS                00:02:01  PIF
03/0/14 ETHERNET PA      1000 OIR_SUCCESS                00:01:59  PIF
03/0/15 ETHERNET PA      1000 OIR_SUCCESS                00:01:57  PIF

09/0/00 OC48c PAM         300 OIR_SUCCESS                00:00:46 Both

10/0/00 QUAD 622 Ge       300 OIR_SUCCESS                00:00:46 Both
10/0/01 QUAD 622 Ge       300 OIR_SUCCESS                00:00:46 Both
10/0/02 QUAD 622 Ge       300 OIR_SUCCESS                00:00:46 Both
10/0/03 QUAD 622 Ge       300 OIR_SUCCESS                00:00:46 Both
```

The following example shows how to display the details and status of the snake test:

```
8540MSR#show diag online snake
========  Online Snake Test Status and Details ========
--------  Test Status --------
Current Test Status    : Test is Enabled
Current Test Type      : Normal Snake
Last Test Status       : Pass
Last Test Run Time     : 1w1d
Last Test Success Time : 1w1d

--------  Test Details --------
Snake Test Pkt Size    : 30 bytes
Default Test Period    : 60 seconds
Current Test Period    : 60 seconds

----------------------------------
      Statistics from Bootup
----------------------------------
Total Test Runs                         : 17311
Number Normal Snake Test Runs           : 17311
Number of Successive Normal Snake Test : 14083
Number of Incrimental Snake Test Runs  : 0

------------------------------------------
      Ports Test Stat in Last Iteration
------------------------------------------

Port      Card Type          Result        Test Time
_______   ________________   __________    _________
09/0/00   OC48c PAM          PORT_OK       1w1d
10/0/00   QUAD 622 Generic   PORT_OK       1w1d
11/0/00   OC48c PAM          PORT_OK       1w1d
12/0/00   QUAD 622 Generic   PORT_OK       1w1d

-----------------------------------------
      Ports Failed Stat from Bootup
-----------------------------------------
     No Port failed from Bootup
```

Configuring SNMP and RMON

SNMP is an application-layer protocol that allows an SNMP manager, such a network management system (NMS), and an SNMP agent on the managed device to communicate. You can configure SNMPv1, SNMPv2, or both, on the ATM switch router. Remote Monitoring (RMON) allows you to see the activity on network nodes. By using RMON in conjunction with the SNMP agent on the ATM switch router, you can monitor traffic through network devices, segment traffic that is not destined for the ATM switch router, and create alarms and events for proactive traffic management.

For detailed instructions on SNMP and general RMON configuration, refer to the *Configuration Fundamentals Configuration Guide*. For instructions on configuring ATM RMON, refer to Chapter 15, "Configuring ATM Accounting, RMON, and SNMP."

Testing the Configuration

The following sections describe tasks you can perform to confirm the hardware, software, and interface configuration:

- Confirming the Hardware Configuration (Catalyst 8540 MSR), page 3-25
- Confirming the Hardware Configuration (Catalyst 8510 MSR and LightStream 1010), page 3-25
- Confirming the Software Version, page 3-26
- Confirming Power-on Diagnostics, page 3-26
- Confirming the Ethernet Configuration, page 3-28
- Confirming the ATM Address, page 3-28
- Testing the Ethernet Connection, page 3-29
- Confirming the ATM Connections, page 3-29
- Confirming the ATM Interface Configuration, page 3-30
- Confirming the Interface Status, page 3-30
- Confirming Virtual Channel Connections, page 3-31
- Confirming the Running Configuration, page 3-32
- Confirming the Saved Configuration, page 3-33

Note The following examples differ depending on whether the switch processor feature card is present. (Catalyst 8540 MSR)

Note The following examples differ depending on the feature card installed on the processor. (Catalyst 8510 MSR and LightStream 1010)

Confirming the Hardware Configuration (Catalyst 8540 MSR)

Use the **show hardware** and **show capability** commands to confirm the correct hardware installation:

```
Switch# show hardware

C8540 named Switch, Date: 08:36:44 UTC Fri May 21 1999

Slot Ctrlr-Type    Part No.   Rev  Ser No  Mfg Date   RMA No. Hw Vrs  Tst EEP
---- ------------  ---------- -- -------- --------- -------- ------- --- ---
 0/* Super Cam     73-2739-02 02 07287xxx Mar 31 98            3.0
 0/0 155MM PAM     73-1496-03 06 02180424 Jan 16 96 00-00-00   3.0     0   2
 0/1 155MM PAM     73-1496-03 00 02180455 Jan 17 96 00-00-00   3.0     0   2
 4/* Route Proc    73-2644-05 A0 03140NXK Apr 04 99 0          5.7
 4/0 Netclk Modul  73-2868-03 A0 03140NSU Apr 04 99 0          3.1
 5/* Switch Card   73-3315-08 B0 03170SMB May 03 99 0          8.3
 5/0 Feature Card  73-3408-04 B0 03160S4H May 03 99 0          4.1
 7/* Switch Card   73-3315-08 B0 03160SDT May 03 99 0          8.3
 7/0 Feature Card  73-3408-04 B0 03160RQV May 03 99 0          4.1
 8/* Route Proc    73-2644-05 A0 03140NXH Apr 04 99 0          5.7
 8/0 Netclk Modul  73-2868-03 A0 03140NVT Apr 04 99 0          3.1

DS1201 Backplane EEPROM:
Model  Ver.  Serial  MAC-Address  MAC-Size  RMA  RMA-Number   MFG-Date
------ ---- -------- ------------ --------  ---  ----------  -----------
C8540  2   6315484 00902156D800   1024      0        0      Mar 23 1999
cubi version : F

Power Supply:
Slot Part No.         Rev  Serial No.  RMA No.     Hw Vrs  Power Consumption
---- ---------------- ---- ----------- ----------- ------- -----------------
0          34-0829-02 A000 APQ0225000R 00-00-00-00   1.0            2746 cA
```

See the Displaying the Switch Processor EHSA Configuration (Catalyst 8540 MSR), page 5-13 for an example of the **show capability** command.

Confirming the Hardware Configuration (Catalyst 8510 MSR and LightStream 1010)

Use the **show hardware** command to confirm the correct hardware installation:

```
Switch# show hardware

LS1010 named ls1010_c5500, Date: XX:XX:XX UTC Thu Jan 8 1998
Feature Card's FPGA Download Version: 10

Slot Ctrlr-Type    Part No.   Rev  Ser No  Mfg Date   RMA No. Hw Vrs  Tst EEP
---- ------------  ---------- -- -------- --------- -------- ------- --- ---
0/0  T1 PAM        12-3456-78 00 00000022 Aug 01 95 00-00-00   0.4     0   2
0/1  T1 PAM        12-3456-78 00 00000025 Aug 01 95 00-00-00   0.4     0   2
1/0  155MM PAM     73-1496-03 06 02180446 Jan 17 96 00-00-00   3.0     0   2
1/1  QUAD DS3 PAM  73-2197-02 00 03656116 Dec 18 96 00-00-00   1.0     0   2
3/0  155MM PAM     73-1496-03 00 02180455 Jan 17 96 00-00-00   3.0     0   2
2/0  ATM Swi/Proc  73-1402-06 D0 07202996 Dec 20 97 00-00-00   4.1     0   2
2/1  FeatureCard1  73-1405-05 B0 07202788 Dec 20 97 00-00-00   3.2     0   2

DS1201 Backplane EEPROM:
Model  Ver.  Serial  MAC-Address  MAC-Size  RMA  RMA-Number   MFG-Date
------ ---- -------- ------------ --------  ---  ----------  -----------
LS1010  2   69000050 00400B0A2E80   256      0        0      Aug 01 1995
```

Confirming the Software Version

Use the **show version** command to confirm the correct version and type of software and the configuration register are installed:

```
Switch# show version
Cisco Internetwork Operating System Software
IOS (tm) PNNI Software (cat8540m-WP-M), Version XX.X(X), RELEASE SOFTWARE
Copyright (c) 1986-1998 by cisco Systems, Inc.
Compiled XXX XX-XXX-XX XX:XX by
Image text-base: 0x600108B4, data-base: 0x6057A000

ROM: System Bootstrap, Version XX.X(X) RELEASE SOFTWARE

Switch uptime is 1 hour, 1 minute
System restarted by reload
System image file is "tftp://cat8540m-wp-mz_nimmu"

cisco C8540MSR (R5000) processor with 65536K/256K bytes of memory.
R5000 processor, Implementation 35, Revision 2.1 (512KB Level 2 Cache)
Last reset from power-on
1 Ethernet/IEEE 802.3 interface(s)
8 ATM network interface(s)
507K bytes of non-volatile configuration memory.

16384K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
8192K bytes of Flash internal SIMM (Sector size 256K).
Configuration register is 0x0
```

Confirming Power-on Diagnostics

Power-on diagnostics test the basic hardware functionality of the system when it is power cycled, when it is reloaded with a new version of power-on diagnostics software, or when you online insert and remove (OIR) a module. The power-on diagnostics test the route processors, switch processors, port adapters, interface modules.

Example (Catalyst 8540 MSR)

The following example displays the power-on diagnostic tests results for the Catalyst 8540 MSR:

```
Switch# show diag power-on
Cat8540 Power-on Diagnostics Status (.=Pass,F=Fail,U=Unknown,N=Not Applicable)
-----------------------------------------------------------------------------
   Last Power-on Date: 1999/07/28   Time: 11:06:12

   BOOTFLASH:   .   PCMCIA-Slot0: .   PCMCIA-Slot1: .
   CPU-IDPROM:  .   NVRAM-Config: .
   ETHSRAM:     .   DRAM:         .   SARSRAM:       .

   PS0:         .   PS2:          N   PS (12V):      .
   FAN:         .   Temperature:  .   Bkp-IDPROM:    .


   Ethernet-port Access:   .          Ethernet-port CAM-Access: .
   Ethernet-port Loopback: .          Ethernet-port Loadgen:    .

Power-on Diagnostics Passed.
```

Example (Catalyst 8510 MSR and LightStream 1010)

The following example displays the power-on diagnostic tests results for the Catalyst 8510 MSR and LightStream 1010:

```
NewLs1010# show diag power-on
LS1010 Power-on Diagnostics Status (.=Pass,F=Fail,U=Unknown,N=Not Applicable)
-----------------------------------------------------------------------------
   Last Power-on Diags  Date: 99/07/09   Time: 07:52:17   By: V 4.51

   BOOTFLASH:  .   PCMCIA-Slot0: .   PCMCIA-Slot1: N
   CPU-IDPROM: .   FCard-IDPROM: .   NVRAM-Config: .
   SRAM:       .   DRAM:         .

   PS1:        .   PS2:          N   PS (12V):     .
   FAN:        .   Temperature:  .   Bkp-IDPROM:   .

   MMC-Switch Access: .              Accordian Access: .
   LUT: .   ITT: .   OPT: .   OTT: .   STK: .   LNK: .   ATTR: .   Queue: .
   Cell-Memory:  .

   FC-PFQ
    Access: .
     RST: .    REG: .    IVC: .    IFILL: .    OVC: .    OFILL: .

    TEST:
     CELL: .   SNAKE: .   RATE: .   MCAST: .   SCHED: .
     TGRP: .   UPC  : .   ABR : .   RSTQ : .

Access/Interrupt/Loopback/CPU-MCast/Port-MCast/FC-MCast/FC-TMCC Test Status:
Ports                      0         1         2         3
----------------------------------------------------------------------------
PAM 0/0 (IMA8T1)        .....NN   .....NN   .....NN   .....NN
    Port 4  to 7 :      .....NN   .....NN   .....NN   .....NN
PAM 0/1 (IMA8E1)        .....NN   .....NN   .....NN   .....NN
    Port 4  to 7 :      .....NN   .....NN   .....NN   .....NN
PAM 1/0 (FR4CE1)       .....NN   .....NN   .....NN   .....NN
PAM 1/1 (155UTP)        .....NN   .....NN   .....NN   .....NN
PAM 3/0 (T1)            .....NN   .....NN   .....NN   .....NN
PAM 3/1 (E1CEUTP)       .....NN   .....NN   .....NN   .....NN
PAM 4/0 (DS3)           .....NN   .....NN      N         N
PAM 4/1 (25M)           .....NN   .....NN   .....NN   .....NN
    Port 4  to 7 :      .....NN   .....NN   .....NN   .....NN
    Port 8  to 11:      .....NN   .....NN   .....NN   .....NN


FRPAM#          ING-SSRAM ING-SDRAM EGR-SSRAM EGR-SDRAM LOOPBACK
------------------------------------------------------------------
PAM 1/0 (FR4CE1)  .        .         .         .         .
   Ethernet-port Access:    .        Ethernet-port CAM-Access: .
   Ethernet-port Loopback:  .        Ethernet-port Loadgen:    .
   GEPAM Microcode:         .        GEPAM Access:            .
   GEPAM CAM Access:        .

Power-on Diagnostics Passed.
```

Confirming the Ethernet Configuration

Use the **show interfaces** command to confirm that the Ethernet interface on the route processor is configured correctly:

```
Switch# show interfaces ethernet 0
Ethernet0 is up, line protocol is up
  Hardware is SonicT, address is 0000.0000.0000 (bia 0000.0000.0000)
  Internet address is 172.20.52.20/26
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 1000 bits/sec, 2 packets/sec
  5 minute output rate 0 bits/sec, 1 packets/sec
     69435 packets input, 4256035 bytes, 0 no buffer
     Received 43798 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 input packets with dribble condition detected
     203273 packets output, 24079764 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

Confirming the ATM Address

Use the **show atm addresses** command to confirm correct configuration of the ATM address for the ATM switch router:

```
Switch# show atm addresses

Switch Address(es):
  47.00918100000000100000001.000100000001.00 active

Soft VC Address(es):
  47.0091.8100.0000.0001.0000.0001.4000.0c80.9000.00 ATM1/1/0
  47.0091.8100.0000.0001.0000.0001.4000.0c80.9010.00 ATM1/1/1
  47.0091.8100.0000.0001.0000.0001.4000.0c80.9020.00 ATM1/1/2
  47.0091.8100.0000.0001.0000.0001.4000.0c80.9030.00 ATM1/1/3
  47.0091.8100.0000.0001.0000.0001.4000.0c81.8000.00 ATM3/0/0
  47.0091.8100.0000.0001.0000.0001.4000.0c81.8000.63 ATM3/0/0.99
  47.0091.8100.0000.0001.0000.0001.4000.0c81.8010.00 ATM3/0/1
  47.0091.8100.0000.0001.0000.0001.4000.0c81.8020.00 ATM3/0/2
  47.0091.8100.0000.0001.0000.0001.4000.0c81.8030.00 ATM3/0/3
  47.0091.8100.0000.0001.0000.0001.4000.0c81.9000.00 ATM3/1/0
  47.0091.8100.0000.0001.0000.0001.4000.0c81.9010.00 ATM3/1/1
  47.0091.8100.0000.0001.0000.0001.4000.0c81.9020.00 ATM3/1/2
  47.0091.8100.0000.0001.0000.0001.4000.0c81.9030.00 ATM3/1/3

 <information deleted>

ILMI Switch Prefix(es):
  47.0091.8100.0000.0001.0000.0001

ILMI Configured Interface Prefix(es):

LECS Address(es):
```

Testing the Ethernet Connection

After you have configured the IP address(es) for the Ethernet interface, test for connectivity between the switch and a host. The host can reside anywhere in your network. To test for Ethernet connectivity, use the following user EXEC command:

Command	Purpose
ping ip *ip-address*	Tests the configuration using the **ping** command. The **ping** command sends an echo request to the host specified in the command.

For example, to test Ethernet connectivity from the switch to a workstation with an IP address of 172.20.40.201, enter the command **ping ip 172.20.40.201**. If the switch receives a response, the following message displays:

```
Switch# ping ip 172.20.40.201

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.20.40.201, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
```

Confirming the ATM Connections

Use the **ping atm interface** command to confirm that the ATM connections are configured correctly:

```
Switch# ping atm interface atm 3/0/0 0 5 seg-loopback

Type escape sequence to abort.
Sending Seg-Loopback 5, 53-byte OAM Echoes to a neighbour,timeout is 5 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
Switch#
```

Confirming the ATM Interface Configuration

Use the **show atm interface** command to confirm the ATM interfaces are configured correctly:

```
Switch# show atm interface atm 1/0/0

Interface:      ATM1/0/0        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      4        0       0       0       1        0       0          5          3
Logical ports(VP-tunnels):     1
Input cells:    263109          Output cells:   268993
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:         1000 bits/sec,       2 cells/sec
Input AAL5 pkts: 171788, Output AAL5 pkts: 174718, AAL5 crc errors: 0
```

Confirming the Interface Status

Use the **show atm status** command to confirm the status of ATM interfaces:

```
Switch# show atm status
NUMBER OF INSTALLED CONNECTIONS: (P2P=Point to Point, P2MP=Point to MultiPoint)

Type       PVCs  SoftPVCs      SVCs       PVPs  SoftPVPs      SVPs      Total
P2P          30         0         0          1         1         0         32
P2MP          0         0         0          1         0         0          1
                                       TOTAL INSTALLED CONNECTIONS =         33

PER-INTERFACE STATUS SUMMARY AT 16:07:59 UTC Wed Nov 5 1997:
   Interface      IF         Admin  Auto-Cfg    ILMI Addr     SSCOP    Hello
     Name       Status      Status    Status    Reg State     State    State
------------- -------- ------------ -------- ------------ --------- --------
ATM1/1/0          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM0                UP           up      n/a  UpAndNormal      Idle      n/a
ATM3/0/0            UP           up      n/a  UpAndNormal    Active  LoopErr
ATM3/0/0.99         UP           up  waiting  WaitDevType      Idle      n/a
ATM3/0/1            UP           up     done  UpAndNormal    Active  LoopErr
ATM3/0/2            UP           up      n/a  UpAndNormal    Active  LoopErr
ATM3/0/3            UP           up     done  UpAndNormal    Active  LoopErr
ATM3/1/0            UP           up     done  UpAndNormal    Active  LoopErr
ATM3/1/1            UP           up     done  UpAndNormal    Active  LoopErr
ATM3/1/2            UP           up     done  UpAndNormal    Active  LoopErr
ATM3/1/3            UP           up     done  UpAndNormal    Active  LoopErr
<information deleted>
```

Confirming Virtual Channel Connections

Use the **show atm vc** command to confirm the status of ATM virtual channel connections:

```
Switch# show atm vc
Interface    VPI   VCI   Type    X-Interface  X-VPI X-VCI  Encap Status
ATM1/1/0     0     5      PVC     ATM0         0     52    QSAAL  DOWN
ATM1/1/0     0     16     PVC     ATM0         0     32    ILMI   DOWN
ATM1/1/1     0     5      PVC     ATM0         0     53    QSAAL  DOWN
ATM1/1/1     0     16     PVC     ATM0         0     33    ILMI   DOWN
ATM1/1/2     0     5      PVC     ATM0         0     54    QSAAL  DOWN
ATM1/1/2     0     16     PVC     ATM0         0     34    ILMI   DOWN
ATM1/1/3     0     5      PVC     ATM0         0     55    QSAAL  DOWN
ATM1/1/3     0     16     PVC     ATM0         0     35    ILMI   DOWN
ATM0         0     32     PVC     ATM1/1/0     0     16    ILMI   DOWN
ATM0         0     33     PVC     ATM1/1/1     0     16    ILMI   DOWN
ATM0         0     34     PVC     ATM1/1/2     0     16    ILMI   DOWN
ATM0         0     35     PVC     ATM1/1/3     0     16    ILMI   DOWN
ATM0         0     36     PVC     ATM3/0/0     0     16    ILMI   UP
ATM0         0     37     PVC     ATM3/0/1     0     16    ILMI   UP
ATM0         0     38     PVC     ATM3/0/2     0     16    ILMI   UP
ATM0         0     39     PVC     ATM3/0/3     0     16    ILMI   UP
ATM0         0     40     PVC     ATM3/1/0     0     16    ILMI   UP
ATM0         0     41     PVC     ATM3/1/1     0     16    ILMI   UP
ATM0         0     42     PVC     ATM3/1/2     0     16    ILMI   UP
ATM0         0     43     PVC     ATM3/1/3     0     16    ILMI   UP
<information deleted>
```

Use the **show atm vc interface** *card/subcard/port* command to confirm the status of ATM virtual channels on a specific interface:

```
Switch# show atm vc interface atm 3/0/0
Interface    VPI   VCI   Type    X-Interface  X-VPI X-VCI  Encap Status
ATM3/0/0     0     5      PVC     ATM0         0     56    QSAAL  UP
ATM3/0/0     0     16     PVC     ATM0         0     36    ILMI   UP
ATM3/0/0     0     18     PVC     ATM0         0     85    PNNI   UP
ATM3/0/0     50    100    PVC     ATM3/0/1     60    200          DOWN
                                  ATM3/0/2     70    210          UP
                                  ATM3/0/3     80    220          UP
ATM3/0/0     100   200    SoftVC  NOT CONNECTED
```

Use the **show atm vc interface atm** *card/subcard/port vpi vci* command to confirm the status of a specific ATM interface and virtual channel connection.

```
Switch# show atm vc interface atm 0/0/0 0 16

Interface: ATM0/0/0, Type: oc3suni
VPI = 0  VCI = 16
Status: DOWN
Time-since-last-status-change: 1w5d
Connection-type: PVC
Cast-type: point-to-point
Packet-discard-option: enabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 15
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0, Type: Unknown
Cross-connect-VPI = 0
Cross-connect-VCI = 35
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
```

```
Cross-connect OAM-state:  Not-applicable
Encapsulation: AAL5ILMI
Threshold Group: 6, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx pkts:0, Rx pkt drops:0
Rx connection-traffic-table-index: 3
Rx service-category: VBR-RT (Realtime Variable Bit Rate)
Rx pcr-clp01: 424
Rx scr-clp01: 424
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: 50
Tx connection-traffic-table-index: 3
Tx service-category: VBR-RT (Realtime Variable Bit Rate)
Tx pcr-clp01: 424
Tx scr-clp01: 424
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: 50
```

Confirming the Running Configuration

Use the **more system:running-config** command to confirm that the current configuration is correct:

```
Switch# more system:running-config
version XX.X
no service pad
no service password-encryption
!
hostname Switch
!
<information deleted>
!
interface Ethernet0
 ip address 172.20.52.11 255.255.255.224
 no ip directed-broadcast
!
interface ATM-E0
 no ip address
 no ip directed-broadcast
 atm pvc 0 29 pd on wrr-weight 15 rx-cttr 3 tx-cttr 3  interface  ATM0 0 any-vci
 wrr-weight 15  encap
!
interface Async1
 no ip address
 no ip directed-broadcast
 hold-queue 10 in
!
logging buffered 4096 debugging
!
line con 0
 exec-timeout 0 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 no login
!
end
```

Confirming the Saved Configuration

Use the **more nvram:startup-config** command to confirm that the configuration saved in NVRAM is correct:

```
Switch# more nvram:startup-config
version XX.X
no service pad
no service password-encryption
!
hostname Switch
!
<information deleted>
!
interface Ethernet0
 ip address 172.20.52.11 255.255.255.224
 no ip directed-broadcast
!
interface ATM-E0
 no ip address
 no ip directed-broadcast
!
interface Async1
 no ip address
 no ip directed-broadcast
 hold-queue 10 in
!
logging buffered 4096 debugging
!
line con 0
 exec-timeout 0 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 no login
!
end
```

Configuring System Management Functions

This chapter describes the basic tasks for configuring general system features, such as access control and basic switch management.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

The following sections describe basic tasks for configuring general system features, such as access control and basic switch management tasks:

System Management Tasks

The role of the administration interface is to provide a simple command-line interface to all internal management and debugging facilities of the ATM switch router.

Configuring Terminal Lines and Modem Support (Catalyst 8540 MSR)

The Catalyst 8540 MSR has a console terminal line that might require configuration. For line configuration, you must first set up the line for the terminal or the asynchronous device attached to it. For a complete description of configuration tasks and commands used to set up your terminal line and settings, refer to the *Dial Solutions Configuration Guide* and *Dial Solutions Command Reference* publications.

You can connect a modem to the console port. The following settings on the modem are required:

- Enable auto answer mode
- Suppress result codes

You can configure your modem by setting the dual in-line package (DIP) switches on the modem or by connecting the modem to terminal equipment. Refer to the user manual provided with your modem for the correct configuration information.

Note Because there are no hardware flow control signals available on the console port, the console port terminal characteristics should match the modem settings.

Configuring Terminal Lines and Modem Support (Catalyst 8510 MSR and LightStream 1010)

The Catalyst 8510 MSR and LightStream 1010 ATM switch routers have two types of terminal lines: a console line and an auxiliary line. For line configuration, you must first set up the lines for the terminals or other asynchronous devices attached to them. For a complete description of configuration tasks and commands used to set up your lines, modems, and terminal settings, refer to the *Dial Solutions Configuration Guide* and *Dial Solutions Command Reference* publications.

Configuring Alias

You can create aliases for commonly used or complex commands. Use word substitutions or abbreviations to tailor command syntax. For detailed instructions on performing these tasks, refer to the *Configuration Fundamentals Configuration Guide* publication.

Configuring Buffers

To make adjustments to initial buffer pool settings and to the limits at which temporary buffers are created and destroyed, use the following global configuration command:

Command	Purpose
buffers {**small** | **middle** | **big** | **verybig** | **large** | **huge** | *type number*}	Configures buffers; the default huge buffer size is 18,024 bytes.
show buffers [**all** | **assigned** [**dump**]]	Displays statistics for the buffer pools on the network server.

To display the buffer pool statistics, use the following privileged EXEC command:

Command	Purpose
show buffers [**address** *hex-addr* | **all** | **assigned** | **free** | **input-interface** *type card/subcard/port* | **old** | **pool** *name* [**dump** | **header** | **packet**]] [**failures**]	Displays statistics for the buffer pools on the network server.

Configuring Cisco Discovery Protocol

To specify how often your ATM switch router sends Cisco Discovery Protocol (CDP) updates, perform the following tasks in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **cdp holdtime** *seconds*	Specifies the hold time in seconds, to be sent in packets.
Step 2	Switch(config)# **cdp timer** *seconds*	Specifies how often your ATM switch router will send CDP updates.
Step 3	Switch(config)# **cdp run**	Enables CDP.

To reset CDP traffic counters to zero (0) on your ATM switch router, perform the following tasks in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **clear cdp counters**	Clears CDP counters.
Step 2	Switch# **clear cdp table**	Clears CDP tables.

To show the CDP configuration, use the following privileged EXEC commands:

Command	Purpose
show cdp	Displays global CDP information.
show cdp *entry-name* [**protocol** | **version**]	Displays information about a neighbor device listed in the CDP table.
show cdp interface [*interface-type interface-number*]	Displays interfaces on with CDP enabled.
show cdp neighbors [*interface-type interface-number*] [**detail**]	Displays CDP neighbor information.
show cdp traffic	Displays CDP traffic information.

Configuring Enable Passwords

To log on to the ATM switch router at a specified level, use the following EXEC command:

Command	Purpose
enable *level*	Enables login.

To configure the enable password for a given level, use the following global configuration command:

Command	Purpose
enable password [**level** *number*] [*encryption-type*] *password*	Configures the enable password.

Configuring Load Statistics Interval

To change the length of time for which data is used to compute load statistics, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface** {**atm** | **ethernet**} **0** Switch(config-if)#	Selects the route processor interface to be configured.
Step 2	Switch(config-if)# **load-interval** *seconds*	Configures the load interval.

Configuring Logging

To log messages to a syslog server host, use the following global configuration commands:

Command	Purpose
logging *host*	Configures the logging name or IP address of the host to be used as a syslog server.
logging buffered [*level* | *size*]	Logs messages to an internal buffer, use the **logging buffered** global configuration command. The **no logging buffered** command cancels the use of the buffer and writes messages to the console terminal, which is the default.
logging console *level*	Limits messages logged to the console based on severity, use the **logging console** global configuration command.
logging facility *type*	Configures the syslog facility in which error messages are sent, use the **logging facility** global configuration command. To revert to the default of local, use the **no logging facility** global configuration command.

Command	Purpose
logging monitor *level*	Limits messages logged to the terminal lines (monitors) based on severity, use the **logging monitor** global configuration command. This command limits the logging messages displayed on terminal lines other than the console line to messages with a level at or above *level.* The **no logging monitor** command disables logging to terminal lines other than the console line.
logging on	Controls logging of error messages, use the **logging on** global configuration command. This command enables or disables message logging to all destinations except the console terminal. The **no logging on** command enables logging to the console terminal only.
logging trap *level*	Limits messages logged to the syslog servers based on severity, use the **logging trap** global configuration command. The command limits the logging of error messages sent to syslog servers to only those messages at the specified level. The **no logging trap** command disables logging to syslog servers.
logging source-interface *type identifier*	Specifies the interface for source address in logging transactions.

Configuring Login Authentication

To enable TACACS+ authentication for logins, perform the following steps, beginning in global configuration mode:

Command	Purpose
line [**aux** | **console** | **vty**] *line-number* [*ending-line-number*]	Selects the line to configure.
login [**local** | **tacacs**]	Configures login authentication.

Configuring Scheduler Attributes

To control the maximum amount of time that can elapse without running the lowest-priority system processes, use the following global configuration commands:

Command	Purpose
scheduler allocate *msecs*	Configures the guaranteed CPU time for processes, in milliseconds. The minimum interval is 500 ms; the maximum value is 6000 ms.
scheduler process-watchdog {**hang** | **normal** | **reload** | **terminate**}	Configures scheduler process-watchdog action for looping processes.
scheduler interval *msecs*	Specifies maximum time in milliseconds that can elapse without running system processes.

Configuring Services

To configure miscellaneous system services, use the following global configuration commands:

Command	Purpose
service alignment	Configures alignment correction and logging.
service compress-config	Compresses the configuration file.
service config	Loads config TFTP files.
service disable-ip-fast-frag	Disables IP particle-based fast fragmentation.
service exec-callback	Enables EXEC callback.
service exec-wait	Configures a delay of the start-up of the EXEC on noisy lines.
service finger	Allows Finger protocol requests (defined in RFC 742) from the network server.
service hide-telnet-addresses	Hides destination addresses in Telnet command.
service linenumber	Enables a line number banner for each EXEC.
service nagle	Enables the Nagle congestion control algorithm.
service old-slip-prompts	Allows old scripts to operate with SLIP/PPP.
service pad	Enables Packet Assembler Dissembler commands.
service password-encryption	Enables encrypt passwords.
service prompt	Enables a mode-specific prompt.
service slave-log	Enables log capability on slave IPs.
service tcp-keepalives {**in** | **out**}	Configures keepalive packets on idle network connections.
service tcp-small-servers	Enables small TCP servers (for example, ECHO).

Command	Purpose
service telnet-zero-idle	Sets the TCP window to zero (0) when the Telnet connection is idle.
service timestamps	Displays timestamp debug/log messages.
service udp-small-servers	Enables small UDP servers (for example, ECHO).

Configuring SNMP

This section describes the Simple Network Management Protocol (SNMP) and Management Information Bases (MIBs) commands used to configure SNMP on your ATM switch router.

For a complete description of the ATM switch router monitoring commands and processes mentioned in this chapter, refer to the following documents:

- Configuring Simple Network Management Protocol (SNMP)
- SNMP Commands

To configure SNMP on your ATM switch router, use the following global configuration commands:

Command	Purpose
snmp-server chassis-id *text*	Provides a message line identifying the SNMP server serial number.
snmp-server community *string* [**view** *view-name*] [**ro** | **rw**] [*number*]	Configures the SNMP community access string.
snmp-server contact *text*	Configures the system contact (syscontact) string.
snmp-server enable	Enables SNMP traps or informs.
snmp-server host [*name* | *IP-address*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**frame-relay**] [*notification-type*]	Configures the recipient of an SNMP trap operation.
snmp-server location *text*	Configures a system location string.
snmp-server packetsize *byte-count*	Configures the largest SNMP packet size permitted when the SNMP server is receiving a request or generating a reply.
snmp-server queue-length *length*	Configures the message queue length for each trap host.
snmp-server system-shutdown	Enables use of the SNMP reload command.
snmp-server trap-timeout *seconds*	Configures how often to resend trap messages on the retransmission queue.
snmp-server view *view-name mib-tree* {**included** | **excluded**}	Configures view entry.

To display the SNMP status, use the following EXEC command:

Command	Purpose
show snmp	Checks the status of communications between the SNMP agent and SNMP manager.

Username Commands

To establish a username-based authentication system at login, use the following global configuration commands:

Command	Purpose
username *name* [**dnis**] [**nopassword** | **password** [*encryption-type*] *password*]	Configures username-based authentication system at login.
username *name* **password** *secret*	Configures username-based CHAP authentication system at login.
username *name* **autocommand** *command*	Configures username-based authentication system at login with an additional command to be added.
username *name* **nohangup**	Configures username-based authentication system at login and prevents Cisco IOS from disconnecting after the automatic command is completed.
username *name* **noescape**	Configures username-based authentication system at login but prevents the user from issuing an escape character on the switch.
username *name* **privilege** *level*	Sets user privilege level.

Configuring the Privilege Level

This section describes configuring and displaying the privilege level access to the ATM switch router. The access privileges can be configured at the global level or at the line level for a specific line.

Configuring Privilege Level (Global)

To set the privilege level for a command, use the following global configuration command:

Command	Purpose
privilege *mode* **level** *number command* [*type*]	Sets the privilege level.

To allow or disallow execution of the **enable** command for privileged access on the secondary route processor, use the following redundancy configuration command:

Command	Purpose
secondary console allow enable-mode	To allow execution of the **enable** command on the secondary route processor.

To display your current level of privilege, use the following privileged EXEC command:

Command	Purpose
show privilege	Displays the privilege level.

Configuring Privilege Level (Line)

To set the default privilege level for a line, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **line** [**aux** | **console** | **vty**] *line-number* [*ending-line-number*]	Selects the line to configure.
Step 2	Switch(config-line)# **privilege level** *number*	Configures the default privilege level.

To display your current level of privilege, use the following privileged EXEC command:

Command	Purpose
show privilege	Displays the privilege level.

Configuring the Network Time Protocol

This section describes configuring the Network Time Protocol (NTP) on the ATM switch router.

To control access to the system NTP services, use the following **ntp** global configuration commands. To remove access control to the system's NTP services, use the **no ntp** command. See the example configuration at the end of this section and the Displaying the NTP Configuration, page 4-12 to confirm the NTP configuration.

To see a list of the NTP commands enter a **?** in EXEC configuration mode. The following example shows the list of commands available for NTP configuration:

```
Switch(config)# ntp ?
  access-group        Control NTP access
  authenticate        Authenticate time sources
  authentication-key  Authentication key for trusted time sources
  broadcastdelay      Estimated round-trip delay
  clock-period        Length of hardware clock tick
  master              Act as NTP master clock
  max-associations    Set maximum number of associations
  peer                Configure NTP peer
  server              Configure NTP server
  source              Configure interface for source address
  trusted-key         Key numbers for trusted time sources
  update-calendar     Periodically update calendar with NTP time
```

To control access to the system NTP services, use the following global configuration command:

Command	Purpose
ntp access-group {**query-only** | **serve-only** | **serve** | **peer**} *access-list-number*	Configures an NTP access group.

To enable NTP authentication, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **ntp authenticate**	Enables NTP authentication.
Step 2	Switch(config)# **ntp authentication-key** *number* **md5** *value*	Defines an authentication key.

To specify that a specific interface should send NTP broadcast packets, perform the following steps, beginning to global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface** *type card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **ntp broadcast** [**client** | **destination** | **key** | **version**]	Configures the system to receive NTP broadcast packets.

As NTP compensates for the error in the system clock, it keeps track of the correction factor for this error. The system automatically saves this value into the system configuration using the **ntp clock-period** global configuration command.

Caution Do not enter the **ntp clock-period** command; it is documented for informational purposes only. The system automatically generates this command as NTP determines the clock error and compensates.

To prevent an interface from receiving NTP packets, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface** *type card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **ntp disable**	Disables the NTP receive interface.

To configure the ATM switch router as a NTP master clock to which peers synchronize themselves when an external NTP source is not available, use the following global configuration command:

Command	Purpose
ntp master [*stratum*]	Configures NTP master clock.

To configure the ATM switch router as a NTP peer that receives its clock synchronization from an external NTP source, use the following global configuration command:

Command	Purpose
ntp peer *ip-address* [**version** *number*] [**key** *keyid*] [**source** *interface*] [**prefer**]	Configures the system clock to synchronize a peer or to be synchronized by a peer.

To allow the ATM switch router system clock to be synchronized by a time server, use the following global configuration command:

Command	Purpose
ntp server *ip-address* [**version** *number*] [**key** *keyid*] [**source** *interface*] [**prefer**]	Configures the system clock to allow it to be synchronized by a time server.

To use a particular source address in NTP packets, use the following global configuration command:

Command	Purpose
ntp source *interface type card/subcard/port*	Configures a particular source address in NTP packets.

To authenticate the identity of a system to which NTP will synchronize, use the following global configuration command:

Command	Purpose
ntp trusted-key *key-number*	Configures an NTP synchronize number.

To periodically update the ATM switch router calendar from NTP, use the following global configuration command:

Command	Purpose
ntp update-calendar	Updates an NTP calendar.

Example

The following example configures the ATM switch router to synchronize its clock and calendar to an NTP server, using ethernet0, and other features:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# ntp server 198.92.30.32
Switch(config)# ntp source ethernet0
Switch(config)# ntp authenticate
Switch(config)# ntp max-associations 2000
Switch(config)# ntp trusted-key 22507
Switch(config)# ntp update-calendar
```

Displaying the NTP Configuration

To show the status of NTP associations, use the following privileged EXEC commands:

Command	Purpose
show ntp associations [**detail**]	Displays NTP associations.
show ntp status	Displays the NTP status.

Examples

The following example displays detail NTP configuration:

```
Switch# show ntp associations detail
198.92.30.32 configured, our_master, sane, valid, stratum 3
ref ID 171.69.2.81, time B6C04E67.6E779000 (18:18:15.431 UTC Thu Feb 27 1997)
our mode client, peer mode server, our poll intvl 128, peer poll intvl 128
root delay 109.51 msec, root disp 377.38, reach 377, sync dist 435.638
delay -3.88 msec, offset 7.7674 msec, dispersion 1.57
precision 2**17, version 3
org time B6C04F19.437D8000 (18:21:13.263 UTC Thu Feb 27 1997)
rcv time B6C04F19.41018C62 (18:21:13.253 UTC Thu Feb 27 1997)
xmt time B6C04F19.41E3EB4B (18:21:13.257 UTC Thu Feb 27 1997)
filtdelay =    -3.88   -3.39   -3.49   -3.39   -3.36   -3.46   -3.37   -3.16
filtoffset =    7.77    6.62    6.60    5.38    4.13    4.43    6.28   12.37
filterror =     0.02    0.99    1.48    2.46    3.43    4.41    5.39    6.36
```

The following example displays the NTP status:

```
Switch# show ntp status
Clock is synchronized, stratum 4, reference is 198.92.30.32
nominal freq is 250.0000 Hz, actual freq is 249.9999 Hz, precision is 2**24
reference time is B6C04F19.41018C62 (18:21:13.253 UTC Thu Feb 27 1997)
clock offset is 7.7674 msec, root delay is 113.39 msec
root dispersion is 386.72 msec, peer dispersion is 1.57 msec
```

Configuring the Clock and Calendar

If no other source of time is available, you can manually configure the current time and date after the system is restarted. The time will remain accurate until the next system restart. Cisco recommends that you use manual configuration only as a last resort.

Note If you have an outside source to which the ATM switch router can synchronize, you do not need to manually set the system clock.

Configuring the Clock

To configure, read, and set the ATM switch router as a time source for a network based on its calendar, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **clock calendar-valid**	Sets the ATM switch router as the default clock.
Step 2	Switch(config)# **clock summer-time** *zone* **recurring** [*week day month hh:mm week day month hh:mm* [*offset*]]	Configures the system to automatically switch to summer time (daylight savings time), use one of the formats of the **clock summer-time** configuration command.
Step 3	Switch(config)# **clock timezone** *zone hours* [*minutes*]	Configures the system time zone.

To manually read and set the calendar into the ATM switch router system clock, perform the following steps in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **clock read-calendar**	Reads the calendar.
Step 2	Switch# **clock set** *hh:mm:ss day month year*	Manually sets the system clock.
Step 3	Switch# **clock update-calendar**	Sets the calendar.

To display the system clock information, use the following EXEC command:

Command	Purpose
show clock [*detail*]	Displays the system clock.

Configuring the Calendar

To set the system calendar, use the following privileged EXEC command:

Command	Purpose
calendar set *hh:mm:ss day month year*	Configures the calendar.

To display the system calendar information, use the following EXEC command:

Command	Purpose
show calendar	Displays the calendar setting.

Configuring TACACS

You can configure the ATM switch router to use one of three special TCP/IP protocols related to TACACS: regular TACACS, extended TACACS, or AAA/TACACS+. TACACS services are provided by and maintained in a database on a TACACS server running on a workstation. You must have access to and configure a TACACS server before configuring the TACACS features described in this publication on your Cisco device. Cisco's basic TACACS support is modeled after the original Defense Data Network (DDN) application.

A comparative description of the supported versions follows. Table 4-1 compares the versions by commands.

- TACACS—Provides password checking, authentication, and notification of user actions for security and accounting purposes.
- Extended TACACS—Provides information about protocol translator and ATM switch router use. This information is used in UNIX auditing trails and accounting files.

  Note The extended TACACS software is available using FTP (refer to the README file in the ftp.cisco.com directory).

- AAA/TACACS+—Provides more detailed accounting information as well as more administrative control of authentication and authorization processes.

You can establish TACACS-style password protection on both user and privileged levels of the system EXEC.

Table 4-1 TACACS Command Comparison

Command	TACACS	Extended TACACS	TACACS+
aaa accounting			X
aaa authentication arap			X
aaa authentication enable default			X
aaa authentication login			X

Table 4-1 TACACS Command Comparison (continued)

Command	TACACS	Extended TACACS	TACACS+
aaa authentication local override			X
aaa authentication ppp			X
aaa authorization			X
aaa new-model			X
arap authentication			X
arap use-tacacs	X	X	
enable last-resort	X	X	
enable use-tacacs	X	X	
login authentication			X
login tacacs	X	X	
ppp authentication	X	X	X
ppp use-tacacs	X	X	X
tacacs-server attempts	X	X	X
tacacs-server authenticate	X	X	
tacacs-server extended		X	
tacacs-server host	X	X	X
tacacs-server key			X
tacacs-server last-resort	X	X	
tacacs-server notify	X	X	
tacacs-server optional-passwords	X	X	
tacacs-server retransmit	X	X	X
tacacs-server timeout	X	X	X

Note Many original TACACS and extended TACACS commands cannot be used after you have initialized AAA/TACACS+. To identify which commands can be used with the three versions, refer to Table 4-1.

Configuring AAA Access Control with TACACS+

To enable the AAA access control model that includes TACACS+, use the following global configuration command:

Command	Purpose
aaa new-model	Enables the AAA access control model.

Configuring AAA Accounting

To enable the AAA accounting of requested services for billing or security purposes when using TACACS+, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **aaa accounting system**	Performs accounting for all system-level events not associated with users, such as reloads.
Step 2	Switch(config)# **aaa accounting network**	Runs accounting for all network-related service requests, including SLIP, PPP, PPP NCPs, and ARAP.
Step 3	Switch(config)# **aaa accounting connection**	Runs accounting for outbound Telnet and rlogin.
Step 4	Switch(config)# **aaa accounting exec**	Runs accounting for Execs (user shells). This keyword might return user profile information such as **autocommand** information.
Step 5	Switch(config)# **aaa accounting commands** *level*	Runs accounting for all commands at the specified privilege level.

Configuring TACACS Server

Refer to the *Security Configuration Guide* for details about the TACACS configuration tasks that include:

- Setting the number of login attempts allowed to the TACACS server
- Enabling extended TACACS mode
- Configuring a TACACS host

Configuring PPP Authentication

Refer to the *Dial Solutions Configuration Guide* for details about the PPP Authentication configuration tasks that include:

- Enabling Challenge Handshake Authentication Protocol (CHAP) or Password Authentication Protocol (PAP)
- Enabling an AAA authentication method on an interface

Configuring RADIUS

RADIUS is a distributed client/server system that secures networks against unauthorized access. RADIUS clients run on ATM switch routers and send authentication requests to a central RADIUS server that contains all user authentication and network service access information. RADIUS is a fully open protocol, distributed in source code format, that can be modified to work with any security system currently available.

Configuring RADIUS Authentication

Refer to the "Configuring Authentication" chapter in the *Cisco IOS Security Configuration Guide* for details about RADIUS authentication configuration tasks such as the following:

- Enabling login authentication method on an interface
- Enabling PPP authentication

Configuring RADIUS Authorization

Refer to the "Configuring Authorization" chapter in the *Cisco IOS Security Configuration Guide* for details about RADIUS authorization configuration tasks such as the following:

- Configuring named method lists
- Configuring authorization attribute-value pairs

Configuring RADIUS Servers

Refer to the "Configuring RADIUS" chapter in the *Cisco IOS Security Configuration Guide* for details on RADIUS server configuration tasks such as the following:

- Configuring vendor-specific RADIUS attributes
- Configuring AAA server groups
- Configuring RADIUS to expand the network access server (NAS) port information

Configuring RADIUS Server Communication

To configure per-server RADIUS server communication on the switch, use the following global configuration commands:

	Command	Purpose
Step 1	Switch(config)# **aaa new-model**	Enables the AAA access control model.
Step 2	Switch(config)# **radius-server host** {*hostname* | *ip-address*} [**auth-port** *number*] [**acct-port** *number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*]	Specifies the host name or IP address of the remote RADIUS server host and assigns authentication and accounting destination port numbers. To configure the network access server to recognize more than one host entry associated with a single IP address, simply repeat this command as many times as necessary, making sure that each UDP port number is different. Set the timeout, retransmit, and encryption key values to use with the specific RADIUS host. **Note** The optional **key** keyword specifies a text string that must match the encryption key used on the RADIUS server. Always configure the key as the last item in the **radius-server host** command syntax because spaces within and at the end of the key are used. Leading spaces are ignored. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks themselves are part of the key.

To configure global communication settings between the switch and a RADIUS server, use the following global configuration commands:

	Command	Purpose
Step 1	Switch(config)# **aaa new-model**	Enables the AAA access control model.
Step 2	Switch(config)# **radius-server key** *string*	Specifies the shared secret text string used between the switch and a RADIUS server.
Step 3	Switch(config)# **radius-server retransmit** *retries*	Specifies the number of times the switch transmits each RADIUS request to the server before giving up.

	Command	Purpose
Step 4	Switch(config)# **radius-server timeout** *seconds*	Specifies the number of seconds a switch waits for a reply to a RADIUS request before retransmitting the request.
Step 5	Switch(config)# **radius-server deadtime** *minutes*	Specifies the number of minutes a RADIUS server, which is not responding to authentication requests, is passed over by requests for RADIUS authentication.

For detailed information about RADIUS commands, refer to the "RADIUS Commands" chapter in the *Cisco IOS Security Command Reference* publication.

Configuring Secure Shell

The preferred method of administering the switch router is through a Telnet session. However, using Telnet might cause security issues that include session hijacking, sniffing, and man-in-the-middle attacks. These attacks can be stopped using the Secure Shell (SSH) protocol and application that the switch router supports. SSH is an application and protocol that provides a secure replacement to the Berkeley r-tools. The protocol secures the sessions using standard cryptographic mechanisms, and the application is similar to the Berkeley rexec and rsh tools. Two versions of SSH are currently available, Version 1 and Version 2. Both SSH Server Version 1 and Version 2 are implemented in the Cisco IOS software. Also, SSH Version 1 Integrated Client and SSH Version 2 Integrated Client are implemented in the Cisco IOS software.

The current method of remotely configuring a switch router involves initiating a Telnet connection to the switch router to start an Exec session and then entering configuration mode. This connection method only provides as much security as Telnet provides. That is, lower-layer encryption (for example, IPSEC [Internet Protocol SECurity]) and application security (for example, username and password authentication at the remote host).

You can configure SSH (Secure Shell) which is an application which runs on top of a reliable transport layer, such as TCP/IP, and provides strong authentication and encryption capabilities. Secure Shell allows you to login onto another computer over a network, execute commands remotely, and move files from one host to another. The requirements are:

- Any host which wants to allow incoming secure connection must have the SSH daemon (or server) running.
- The SSH client is required to initiate a connection to the remote host.

The IOS/ENA implementation of SSH server on the switch router provides the following:

- Secure incoming connections
- Remote Exec session connections to the switch router
- DES and 3DES encryption
- Username and password authentication using the existing IOS/ENA AAA authentication functions

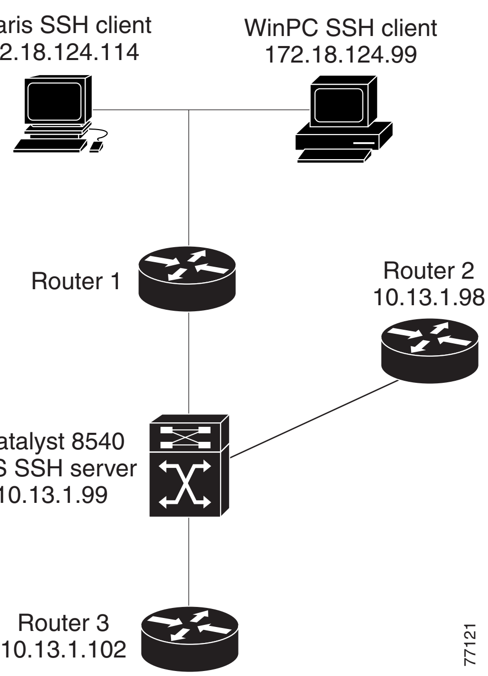
For additional information about SSH, see the following:

- *Secure Shell White Paper* provided by SSH Communications Security
- *Secure Shell Version 1 Support* example configuration
- *Secure Shell Version 1 Integrated Client*

Note When you use the **redundancy force-failover main-cpu (Catalyst 8540 MSR)** command to manually force the secondary route processor to take over as the primary route processor the SSH RSA key pair is automatically generated on the new primary route processor. This ensures that the SSH server is enabled on the switch router even after route processor switchover and allows you to start configuring the new primary route processor using a new SSH connection without reloading the switch router.

Figure 4-1 is an example of a SSH network using a Catalyst 8540 MSR as the SSH server.

Figure 4-1 Secure Shell Example Network



To configure SSH on the ATM switch router, perform the following steps in global EXEC mode:

	Command	Purpose
Step 1	Switch(config)# **hostname** *name*	Sets the host name.
Step 2	Switch(config)# **ip domain-name** *name*	Configures the switch router IP domain name.
Step 3	Switch(config)# **crypto key** {{**generate rsa** [**usage-keys**] [**modulus** *modulus-value*]} | {**pubkey-chain rsa** | **zeroize rsa**}}	Generates an RSA key pair.
Step 4	Switch(config)# **ip ssh version** {*version-number*}	Configures the SSH server version.

Example

The following example shows how to configure the SSH client and start the SSH server:

```
Cat8540(config)# hostname Cat8540
Cat8540(config)# ip domain-name cisco.com
Cat8540(config)# crypto key generate rsa
```

The following example shows how to configure SSH server version 2:

```
Cat8540(config)# ip ssh version 2
Cat8540(config)#
```

To start SSH client functionality on the ATM switch router, perform the following step:

Command	Purpose
Switch# **ssh** [**-l** *userid*] [**-v** *ssh_client_version_number*] [**-m** *hmac_algorithm_type*] [**-c** {**des** | **3des** | **aes128-cbc** | **aes192-cbc** | **aes256-cbc**}] [**-o numberofpasswdprompts** *number*] [**-p** *portnumber*] {*ip_address* | *hostname*} [*command*(*command*(*command*...))[1]]	Starts the SSH client.

1. (Optional) Specifies the Cisco IOS command that you want to run on the remote networking device. If the remote host is not running Cisco IOS software, this may be any command recognized by the remote host. If the command includes spaces, you must enclose the command in quotation marks.

Note You can run the SSH client configuration from any EXEC configuration level.

Example

The following example shows the SSH client using aes128-cbc cipher and hmac-md5-96 HMAC algorithm to initiate a secure remote command connection with the Router2 router. The SSH server running on Router2 authenticates the session for the admin7 user on the Router2 router using standard authentication methods and returns the result of the **show ip route** command to the local switch router.

Note The Router2 router must have SSH enabled for this to work.

```
Cat8540# ssh -l admin7 -v 2 -m hmac-md5-128 -c aes128-cbc -o numberofpasswordprompts 4
Router2 "show ip route"

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set
.
[Information Deleted]
.
Cat8540#
```

Displaying and Disconnecting SSH

To display the SSH utilization, use the following privileged EXEC command:

Command	Purpose
show ssh	Displays SSH connection information.
disconnect ssh *session-id*	Disconnects an SSH session.
show ip ssh	Displays the SSH configuration.

Examples

The following example displays the SSH configuration on the switch router:

```
Cat8540# show ssh
Connection      Version Encryption      State                   Username
 0              1.5     3DES            Session started         aarun
```

The following example clears the outgoing SSH connection 0 using the **disconnect ssh** command:

```
Cat8540# disconnect ssh 0

[Connection to 10.13.1.98 closed by foreign host]
Cat8540#
```

The following example is sample output from the **show ip ssh** privileged EXEC command when the SSH server is enabled.

```
Switch# show ip ssh
SSH Enabled - version 1.5
Authentication timeout: 120 secs; Authentication retries: 3
```

The following example is sample output from the **show ip ssh** privileged EXEC command when the SSH server is disabled.

```
Switch# show ip ssh
SSH Disabled - version 1.5
%Please create RSA keys to enable SSH.
```

Testing the System Management Functions

This section describes the commands used to monitor and display the system management functions.

Displaying Active Processes

To display information about the active processes, use the following privileged EXEC commands:

Command	Purpose
show processes	Displays active process statistics.
show processes cpu	Displays active process CPU utilization.
show processes memory	Displays active process memory utilization.

Displaying Protocols

To display the configured protocols, use the following privileged EXEC command:

Command	Purpose
show protocols *type card/subcard/port*	Displays the global and interface-specific status of any configured Level 3 protocol; for example, IP, DECnet, Internet Packet Exchange (IPX), and AppleTalk.

Displaying Stacks

To monitor the stack utilization of processes and interrupt routines, use the following privileged EXEC command:

Command	Purpose
show stacks *number*	Displays system stack trace information.

The **show stacks** display includes the reason for the last system reboot. If the system was reloaded because of a system failure, a saved system stack trace is displayed. This information is of use only to Cisco engineers analyzing crashes in the field. It is included here in case you need to read the displayed statistics to an engineer over the phone.

Displaying Routes

To discover the IP routes that the ATM switch router packets will actually take when traveling to their destination, use the following EXEC command:

Command	Purpose
traceroute [*protocol*] [*destination*]	Displays packets through the network.

Displaying Environment

To display temperature and voltage information on the ATM switch router console, use the following EXEC command:

Command	Purpose
show environment	Displays temperature and voltage information.

Checking Basic Connectivity (Catalyst 8540 MSR)

To diagnose basic ATM network connectivity on the Catalyst 8540 MSR, use the following privileged EXEC command:

Command	Purpose
ping atm interface atm *card***/***subcard***/***port* *vpi* [*vci*] {**end-loopback** [*destination*] | **ip-address** *ip-address* | **seg-loopback** [*destination*]}	Uses **ping** to check the ATM network connection.

Checking Basic Connectivity (Catalyst 8510 MSR and LightStream 1010)

To diagnose basic ATM network connectivity on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers, use the following privileged EXEC command:

Command	Purpose
ping atm interface atm *card***/***subcard***/***port* *vpi* [*vci*] {**atm-prefix** *prefix* | **end-loopback** [*destination*] | **ip-address** *ip-address* | **seg-loopback** [*destination*]}	Uses **ping** to check the ATM network connection.

Configuring Redundancy

The Catalyst 8540 MSR supports redundant CPU operation with dual route processors. In addition, Enhanced High System Availability (EHSA) is provided in the switching fabric when three switch processors are installed in the chassis. These features and their configuration are described in the following sections:

Route Processor Redundant Operation (Catalyst 8540 MSR)

The Catalyst 8540 MSR supports fault tolerance by allowing a secondary route processor to take over if the primary fails. This secondary, or redundant, route processor runs in standby mode. In standby mode, the secondary route processor is partially booted with the Cisco IOS software; however, no configuration is loaded.

At the time of a switchover, the secondary route processor takes over as primary and loads the configuration as follows:

- If the running configuration between the primary and secondary route processors match, the new primary uses the running configuration file.
- If the running configuration between the primary and secondary route processors do not match, the new primary uses the last saved configuration file in its nonvolatile random-access memory (NVRAM), not the NVRAM of the former primary.

The former primary then becomes the secondary route processor.

Note If the secondary route processor is unavailable, a major alarm is reported. Use the **show facility-alarm status** command to display the redundancy alarm status.

When the Catalyst 8540 MSR is powered on, the two route processors go through an arbitration to determine which is the primary route processor and which is the secondary. The following rules apply during arbitration:

- A newly inserted route processor card always comes up as the secondary, except in cases where the newly inserted card is the only one present.
- If the configuration is corrupted, one of the route processors comes up as primary, allowing you to correct the situation manually.
- The primary route processor at the time the Catalyst 8540 MSR is powered off continues as the primary when the Catalyst 8540 MSR is powered on.
- If none of the above conditions is true, the route processor in slot 4 becomes the primary.

During normal operation, the primary route processor is booted completely. The secondary CPU is partially up, meaning it stops short of parsing the configuration. From this point, the primary and secondary processors communicate periodically to synchronize any system configuration changes.

The following situations can cause a switchover of the primary route processor:

- The primary route processor is removed or swapped. When a route processor functioning as primary is removed, the secondary takes over. The Catalyst 8540 MSR is now nonredundant until a second route processor is inserted.
- The primary route processor is rebooted. When a route processor functioning as primary is rebooted, the secondary takes over.
- The primary route processor fails. The secondary route processor takes over as primary, using the last saved configuration (or the current running configuration if they have been synchronized with the **sync config** command).
- A switchover is manually forced with the **redundancy force-failover main-cpu** command.

When a switchover occurs, permanent virtual connections (PVCs) are preserved. Transit switched virtual circuits (SVCs) and soft PVCs are preserved if the switch is configured to synchronize dynamic information (see the Synchronizing the Dynamic Information (Catalyst 8540 MSR), page 5-7).Terminating SVCs and Integrated Local Management Interface (ILMI) address states are lost, and then restored after they are dynamically redetermined.

Table 5-1 lists various ATM connection types and whether or not they are preserved during a route processor switchover.

Table 5-1 Connection Preservation During Route Processor Switchover

Connection Type	Preserved During Switchover
PVC	Yes
PVP	Yes
Point-to-Multipoint PVC	Yes
Point-to-Multipoint PVP	Yes
SVC	Yes
SVP	Yes
Point-to-Multipoint SVC	Yes
MP2P SVC	Yes
Point-to-Multipoint SVP	Yes
Soft PVC (single-ended)	Yes

Table 5-1 Connection Preservation During Route Processor Switchover (continued)

Connection Type	Preserved During Switchover
Soft PVC (two-ended)	Yes
Point-to-Multipoint Soft PVC	Yes
Soft PVC Termination on CPU	No
SPVP	Yes
CES PVC	Yes
CES SVC	Yes
CES Soft PVC	Yes
Frame Relay PVC	Yes
Frame Relay Soft PVC	No

Configuring Route Processor Redundancy (Catalyst 8540 MSR)

For redundant operation, the following requirements must be met:

- Two route processors and three switch cards are required.
- The route processors must have identical hardware configurations. This includes variables such as DRAM size, presence or absence of network clock modules, and so on.
- Both route processors must have the same functional image. For more information, see Chapter 26, "Managing Configuration Files, System Images, and Functional Images."
- Both route processors must be running the same system image.
- Both route processors must be set to autoboot (a default setting).

If these requirements are met, the Catalyst 8540 MSR runs in redundant mode by default. The tasks described in the following sections are optional and used only to change nondefault values.

Forcing a Route Processor Switchover (Catalyst 8540 MSR)

You can manually force the secondary route processor to take over as the primary using the **redundancy force-failover main-cpu (Catalyst 8540 MSR)** command.

Note When you use the **redundancy force-failover main-cpu (Catalyst 8540 MSR)** command the SSH RSA key pair is automatically generated on the new primary route processor. For more information, see Chapter 4, "Configuring Secure Shell."

To force the secondary route processor to take over as the primary, use the following privileged EXEC command:

Command	Purpose
redundancy force-failover main-cpu	Forces a route processor switchover.

Example

The following example shows how to make the secondary route processor the primary.

```
Switch# redundancy force-failover main-cpu
```

The following example shows the warning message that appears if you attempt to force a failover between route processors whose Cisco IOS images are significantly different.

```
Switch# redundancy force-failover main-cpu

Warning: Attempting to migrate to a different version of system image than the primary.
  Do you want to continue? Y
```

Note If the translation functions needed to migrate the databases during the route processor switchover are significant, the warning message in the previous example appears asking you to confirm the upgrade or downgrade.

As long as you have not changed the default configuration register setting, which is set to autoboot by default, the secondary route processor (formerly the primary) completes the boot process from standby mode.

If you have changed the default configuration register value, you can change it back to autoboot, and ensure that the correct system image is used at startup, by performing the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **config-register 0x2102**	Sets the config register for autoboot.
Step 2	Switch(config)# **boot system** {[*device*:]*filename* [*hostname* | *ip-address*] | **flash** [*device*:][*filename*] | **mop** *filename* [*type*] [*card*/*subcard*/*port*] | **rcp** *filename* [*ip-address*] | **rom** | **tftp** *filename* [*hostname* | *ip-address*]}	Specifies the system image file to load at startup.
Step 3	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 4	Switch# **copy system:running-config nvram:startup-config**	Saves the configuration to NVRAM.

Note If the secondary route processor remains in ROM monitor mode, you can manually boot the processor from either the bootflash or Flash PC card.

Caution If no system image is specified in the startup configuration, the ROM monitor automatically boots the first system image on the Flash PC card in slot0. If there is no system image on the Flash PC card, or the Flash PC card is not available, the ROM monitor boots the first system image in bootflash. If there is no system image in bootflash, the switch remains in ROM monitor mode.

Displaying the Configuration Register Value

To display the configuration register value, use the following privileged EXEC command:

Command	Purpose
show version	Displays the configuration register value.

The following example shows the configuration register value:

```
Switch# show version
Cisco Internetwork Operating System Software
IOS (tm) PNNI Software (cat8540m-WP-M), Version XX.X(X)WX(X),  RELEASE SOFTWARE
Copyright (c) 1986-19XX by cisco Systems, Inc.
Compiled Mon XX-XXX-XX 10:15 by integ
Image text-base: 0x60010930, data-base: 0x606CE000

ROM: System Bootstrap, Version XX.XXX.X(X)WX(X) [BLD-JAGUAR120-4.0.9 ], E

Switch uptime is 3 weeks, 5 days, 23 hours, 30 minutes
System restarted by bus error at PC 0x6007EF24, address 0xFC
System image file is "bootflash:cat8540m-wp-mz.XXX-X.X.WX.X.XX"

cisco C8540MSR (R5000) processor with 65536K/256K bytes of memory.
R5000 processor, Implementation 35, Revision X.X (512KB Level 2 Cache)
Last reset from power-on
1 Ethernet/IEEE 802.3 interface(s)
9 ATM network interface(s)
507K bytes of non-volatile configuration memory.

8192K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
8192K bytes of Flash internal SIMM (Sector size 256K).
Secondary is up
Secondary has 0K bytes of memory.

Configuration register is 0x100 (will be 0x2102 at next reload)
```

Synchronizing the Configurations (Catalyst 8540 MSR)

During normal operation, the startup and running configurations are synchronized by default between the two route processors. In the event of a switchover, the new primary route processor uses the current configuration. Configurations synchronize either immediately from the command line or during route processor switchover.

Immediately Synchronizing Route Processor Configurations (Catalyst 8540 MSR)

To immediately synchronize the configurations used by the two route processors, use the following privileged EXEC command on the primary route processor:

Command	Purpose
redundancy manual-sync {**startup-config** | **running-config** | **both**}	Immediately synchronizes the configuration.

Example

In the following example, both the startup and running configurations are synchronized immediately:

```
Switch# redundancy manual-sync both
```

Immediately Synchronizing Route Processor Counters (Catalyst 8540 MSR)

To immediately synchronize the VC, interface, and signaling counters between primary and secondary route processors, use the following privileged EXEC command on the primary route processor:

Command	Purpose
redundancy manual-sync counters	Immediately synchronizes the VC, interface, and signaling counters between route processors.

Example

In the following example all VC, interface, and signaling counter values are synchronized from the primary to secondary route processors:

```
Switch# redundancy manual-sync counters
```

Synchronizing the Configurations During Switchover (Catalyst 8540 MSR)

To synchronize the configurations used by the two route processors during a switchover, perform the following steps on the primary route processor, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **redundancy** Switch(config-r)#	Enters redundancy configuration mode.
Step 2	Switch(config-r)# **main-cpu** Switch(config-r-mc)#	Enters main CPU configuration submode.
Step 3	Switch(config-r-mc)# **sync config** {**startup** | **running** | **both**}[1]	Synchronizes either or both configurations during switchover or writing the files to NVRAM.

	Command	Purpose
Step 4	Switch(config-r-mc)# **end** Switch#	Returns to privileged EXEC mode.
Step 5	Switch# **copy system:running-config nvram:startup-config**	Forces a manual synchronization of the configuration files in NVRAM. **Note** This step is unnecessary to synchronize the running configuration file in DRAM.

1. Alternatively, you can force an immediate synchronization by entering the **redundancy manual-sync** command in privileged EXEC mode.

Example

In the following example, both the startup and running configurations are synchronized:

```
Switch(config)# redundancy
Switch(config-r)# main-cpu
Switch(config-r-mc)# sync config both
Switch(config-r-mc)# end
Switch# copy system:running-config nvram:startup-config
```

Synchronizing the Dynamic Information (Catalyst 8540 MSR)

During normal operation, the dynamic state information about transit SVCs, transit or endpoint soft PVCs, and point-to-multipoint soft PVCs, is synchronized by default between the primary and backup route processors. Dynamic synchronization can be disabled if required.

Note You must also enable synchronization of the running configuration to ensure synchronization of the dynamic information.

Configuring Dynamic Information Synchronization (Catalyst 8540 MSR)

To synchronization the dynamic information about transit SVCs, plus, transit and endpoint soft PVCs (both point-to-point and point-to-multipoint), during a route processor switchover, perform the following steps on the primary route processor, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **redundancy** Switch(config-r)#	Enters redundancy configuration mode.
Step 2	Switch(config-r)# **main-cpu** Switch(config-r-mc)#	Enters main CPU configuration submode.
Step 3	Switch(config-r-mc)# **sync config running**	Enables running configuration synchronization during route processor switchover.
Step 4	Switch(config-r-mc)# **sync dynamic-info**	Enables dynamic information synchronization during a route processor switchover.[1]

	Command	Purpose
Step 5	Switch(config-r-mc)# **end** Switch#	Returns to privileged EXEC mode.
Step 6	Switch# **copy system:running-config nvram:startup-config**	Copies the configuration to NVRAM.

1. The **sync-dynamic info** command is enabled by default.

Example

In the following example, both the running configuration and dynamic information are synchronized:

```
Switch(config)# redundancy
Switch(config-r)# main-cpu
Switch(config-r-mc)# sync config running
Switch(config-r-mc)# sync dynamic-info
Switch(config-r-mc)# end
Switch# copy system:running-config nvram:startup-config
```

Configuring Counter Synchronization (Catalyst 8540 MSR)

To configure synchronizing of the VC, interface, and signaling counters between the primary and secondary route processors, perform the following steps on the primary route processor, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **redundancy** Switch(config-r)#	Enters redundancy configuration mode.
Step 2	Switch(config-r)# **main-cpu** Switch(config-r-mc)#	Enters main CPU configuration submode.
Step 3	Switch(config-r-mc)# **sync counters vc** *minutes*	Enables periodic synchronization of the VC counters between the route processors.
Step 4	Switch(config-r-mc)# **sync counters interface** *minutes*	Enables periodic synchronization of the VC counters between the route processors.
Step 5	Switch(config-r-mc)# **sync counters signaling**	Enables synchronization of signaling events between the route processors.
Step 6	Switch(config-r-mc)# **end** Switch#	Returns to privileged EXEC mode.
Step 7	Switch# **copy system:running-config nvram:startup-config**	Copies the configuration to NVRAM.

Note The counters of the primary and secondary route processors might not match exactly because the counters are only updated periodically. The difference depends on the frequency of the updates.

Example

The following example shows how to enable and configure the time interval for interface, VC, and signaling counter updates between the primary and secondary route processors.

```
Switch# configure terminal
Switch(config)# redundancy
Switch(config-r)# main-cpu
Switch(config-r-mc)# sync counters vc 60
Switch(config-r-mc)# sync counters interface 60
Switch(config-r-mc)# sync counters signaling
```

Displaying the Route Processor Redundancy Configuration (Catalyst 8540 MSR)

To display the route processor redundancy configuration, use the following privileged EXEC commands:

Command	Purpose
show redundancy	Displays the redundancy configuration and status.
more system:running-config	Displays the current running configuration.

The following example shows the route processor redundancy configuration:

```
Switch# show redundancy
This CPU is the PRIMARY
Primary
-------
Slot:                          4
CPU Uptime:                    25 minutes
ILMI sysUpTime:                25 minutes
Image:                         PNNI Software (cat8540m-WP-M), Experimental
Version 12.1(20030605:120716) [mumahesh-counters-5june 163]

Time Since :
  Last Running Config. Sync:   21 minutes
  Last Startup Config. Sync:   21 minutes
Module Syncs are ENABLED
Init Sync is Complete
Interface counters syncs are DISABLED
VC counters syncs are DISABLED
Signaling counters syncs are DISABLED
Last Restart Reason:           Switch Over
Time since switchover:         1 minute
Last Switchover duration:      52 seconds


Secondary
---------
State:                         UP
Slot:                          8
Uptime:                        23 minutes
Image:                         PNNI Software (cat8540m-WP-M), Experimental
Version 12.1(20030605:120716) [mumahesh-counters-5june 163]

Switch#
```

```
8540MSR# more system:running-config
!
version 12.1
service config
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname 8540MSR
!
logging buffered 4096 debugging
no logging console
enable password lab
!
spd headroom 1024
no facility-alarm core-temperature major
no facility-alarm core-temperature minor
redundancy
 main-cpu
  sync dynamic-info
  sync config startup
  sync config running
network-clock-select revertive
 --More--
```

Preparing a Route Processor for Removal (Catalyst 8540 MSR)

Before removing a route processor that is running the IOS in secondary mode, it is necessary to change it to ROM monitor mode. You could use the reload command to force the route processor to ROM monitor mode but the automatic reboot would occur and you would interrupt switch traffic.

Caution If you fail to prepare the secondary route processor for removal, the traffic through the switch could be interrupted.

To change the secondary route processor to ROM monitor mode and eliminate the automatic reboot prior to removal, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **copy system:running-config nvram:startup-config**	Forces a manual synchronization of the configuration files in NVRAM.
Step 2	Switch)# **redundancy prepare-for-cpu-removal**	Changes the current route processor to ROM monitor mode prior to removal.

Example

The following example shows how to change the current route processor to ROM monitor mode prior to removal:

```
Switch# copy system:running-config nvram:startup-config
Destination filename [startup-config]?
Building configuration...

EHSA:Syncing monvars to secondary, : BOOT=
EHSA:Syncing monvars to secondary, : CONFIG_FILE=
```

```
EHSA:Syncing monvars to secondary, : BOOTLDR=[OK]
Switch#
Switch# redundancy prepare-for-cpu-removal
This command will cause this CPU to go to the
rom monitor through a forced crash.
After this cpu goes to the rom monitor prompt, it is
safe to remove it from the chassis
Please DO NOT REBOOT this cpu before removing it
Do you want to remove it?[confirm]y

Queued messages:
1d22h: %SYS-3-LOGGER_FLUSHING: System pausing to ensure console debugging outpu.

*** System received a reserved exception ***
signal= 0x9, code= 0x0, context= 0x61818df8
PC = 0x600b62e0, Cause = 0x20, Status Reg = 0x34008702
AT: be840000, V0: 9, V1: 0
A0: 2b, A1: 9, A2: 0
A3: 61818df8, T0: 30, T1: 34008701
T2: 34008700, T3: ffff00ff, T4: 61059f88
T5: 7f, T6: 0, T7: 0
S0: 34008701, S1: 1, S2: 9
S3: 0, S4: 61818df8, S5: 611f8540
S6: 611e3740, S7: 61363710, T8: 47d1
T9: 618189d8, K0: 61612634, K1: 600b7e30
GP: 61177fa0, SP: 61818da8, S8: 611e3740
RA: 600a81b8
STATUS: 34008702
mdlo_hi: 0, mdlo: 0
mdhi_hi: 0, mdhi: 0
bvaddr_hi: ffffffff, bvaddr_lo: ffffffff
cause: 20, epc_hi: 0, epc:600b62e0
err_epc_hi: 0, err_epc: 200004
TIGER Masked Interrupt Register = 0x0000007f
TIGER Interrupt Value Register = 0x00000020

monitor: command "boot" @Ø--<ÒagZç
rommon 3 >
```

Configuring Switch Fabric Enhanced High System Availability Operation (Catalyst 8540 MSR)

Slots 5, 6, and 7 in the Catalyst 8540 MSR chassis can accommodate either two or three switch processor cards, with a switching capacity of 10 Gbps each. The possible configurations are as follows:

- Two switch processors—20 Gbps non-EHSA switching fabric (no spare)
- Three switch processors—20 Gbps EHSA switching fabric (one spare)

When three switch processors are installed, two are active at any time, while the third runs in standby mode. By default, switch processors 5 and 7 are active and switch processor 6 is the standby. To force the standby switch processor to become active, use the **redundancy preferred-switch-card-slots** command.

Caution Do not hot swap an active switch processor module before putting it in standby mode. Removing an active switch processor breaks active connections and stops the flow of traffic through the switch. Put an active switch in standby mode using the **redundancy preferred-switch-card-slots** command before removing it from the chassis.

When a switchover to the standby switch processor occurs, the system resets and all connections are lost. When the system comes up again, all PVCs, PVPs, Soft VCs, and Soft VPs are reestablished automatically.

Configuring Preferred Switching Processors (Catalyst 8540 MSR)

To configure which two of the three switch processors are active and which runs in standby mode, use the following privileged EXEC command on the primary route processor:

Command	Purpose
r**edundancy preferred-switch-card-slots** {**5** | **6** | **7**} {**5** | **6** | **7**}	Configures the active and standby switch processors.

Example

In the following example, the preferred switch processors are configured to be in slots 5 and 7 with the slot 6 switch processor running in standby mode:

```
Switch# redundancy preferred-switch-card-slots 5 7
The preferred switch cards selected are already active
```

Note The preferred switch card slot configuration reverts to the default configuration when the switch is power cycled.

Displaying the Preferred Switch Processor Redundancy Configuration (Catalyst 8540 MSR)

To display the preferred switch processor redundancy configuration, use the following privileged EXEC commands:

Command	Purpose
show preferred-switch-card-slots	Displays the preferred switch processor configuration.
show switch fabric	Displays the switch processor status.

The following example shows the preferred switch processor configuration and status:

```
Switch# show preferred-switch-card-slots
→ The currently preferred switch card slots are slot: 5 and slot: 7
→ The currently active switch card slots are slot: 5 and slot: 7
Switch# show switch fabric
swc_presence_mask: 0x5
Switch mode: NR_20G
Number of Switch Cards present in the Chassis: 2
```

```
SWC SLOT             SWC_TYPE         SWC_STATUS
=================================================

→      5              EVEN              ACTIVE
→      6              NOT-PRESENT       NOT-PRESENT
→      7              ODD               ACTIVE

<information deleted>
```

Displaying the Switch Processor EHSA Configuration (Catalyst 8540 MSR)

To display the switch processor EHSA configuration, use the following privileged EXEC command:

Command	Purpose
show capability {**primary** | **secondary**}	Displays the switch redundancy configuration.

The following example shows the primary switch processor EHSA configuration:

```
Switch# show capability primary
 Dram Size is :64 MB
 Pmem Size is :4 MB
 Nvram Size is :512 KB
 BootFlash Size is :8 MB
 ACPM hw version 5.2
 ACPM functional version 4.0
 Netclk Module present flag :16
 NCLK hw version 3.1
 NCLK func version 8.0

 Printing the parameters for Switch card: 0
 SWC0 HW version 7.2
 SWC0 Functional version 1.2
 SWC0 Table memory size: 0 MB
 SWC0 Feat Card Present Flag: 0
 SWC0 Feat Card HW version 0.0
 SWC0 Feat Card Functional version 0.0

 Printing the parameters for Switch card: 1
 SWC1 HW version 0.0
 SWC1 Functional version 0.0
 SWC1 Table memory size: 0 MB
 SWC1 Feat Card Present Flag: 0
 SWC1 Feat Card HW version 0.0
 SWC1 Feat Card Functional version 0.0

 Printing the parameters for Switch card: 2
 SWC2 HW version 7.2
 SWC2 Functional version 1.2
 SWC2 Table memory size: 0 MB
 SWC2 Feat Card Present Flag: 0
 SWC2 Feat Card HW version 0.0
 SWC2 Feat Card Functional version 0.0

 Number of Controller supported in IOS: 7
```

```
Driver 0 type: 2560 super cam Functional Version 1.3

Driver 1 type: 2562 OC12 SPAM Functional Version 5.1

Driver 2 type: 2564 OC mother board Functional Version 5.1

Driver 3 type: 258 Switch Card Functional Version 1.0

Driver 4 type: 259 Switch Feature Card Functional Version 4.0
```

Storing the Configuration

When autoconfiguration and any manual configurations are complete, you should copy the configuration into nonvolatile random-access memory (NVRAM). If you should power off your ATM switch router prior to saving the configuration in NVRAM, all manual configuration changes are lost.

To save the running configuration to NVRAM, use the following command in privileged EXEC mode:

Command	Purpose
copy system:running-config nvram:startup-config	Copies the running configuration in system memory to the startup configuration stored in NVRAM.

Configuring ATM Network Interfaces

This chapter describes how to explicitly configure ATM network interface types. Explicitly configuring interfaces is the alternative to Integrated Local Management Interface (ILMI) autoconfiguration, which senses the peer interface type and appropriately configures the interface on the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For a discussion and examples of ATM network interface types, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

The network configuration tasks described in this chapter are used to explicitly change your ATM switch router operation from the defaults, which are suitable for most networks. The following sections are included:

Disabling Autoconfiguration

Autoconfiguration determines an interface type when the interface initially comes up. To change the configuration of the interface type (such as UNI, NNI, or IISP), side, or version, you must first disable autoconfiguration.

Note When you change the interface type, side, or version, ATM signalling and ILMI are restarted on the interface. When ATM signalling is restarted, all switched virtual connections (SVCs) across the interface are cleared; permanent virtual connections are not affected.

To disable autoconfiguration on an interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm auto-configuration**	Disables autoconfiguration on the interface.

Example

The following example shows how to disable autoconfiguration on interface ATM 1/0/0:

```
Switch(config)# interface atm 1/0/0
Switch(config-if)# no atm auto-configuration
Switch(config-if)#
%ATM-6-ILMINOAUTOCFG: ILMI(ATM1/0/0): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
```

Displaying the Autoconfiguration

To confirm that autoconfiguration is disabled for the interface, use the following EXEC command:

Command	Purpose
show atm interface atm *card***/***subcard***/***port*	Shows the ATM interface configuration.

Example

The following example shows the autoconfiguration status of ATM interface 1/0/0 as disabled:

```
Switch# show atm interface atm 1/0/0

Interface:      ATM1/0/0        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      4        0       0       0       1        0       0          5          3
Logical ports(VP-tunnels): 0
Input cells:    263250          Output cells:   269783
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 171880, Output AAL5 pkts: 175134, AAL5 crc errors: 0
```

Configuring UNI Interfaces

The User-Network Interface (UNI) specification defines communications between ATM end stations (such as workstations and routers) and ATM switches in private ATM networks.

To configure a UNI interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm auto-configuration**	Disables autoconfiguration on the interface.
Step 3	Switch(config-if)# **atm uni** [**side** {**network** | **user**}] [**type** {**private** | **public**}] [**version** {**3.0** | **3.1** | **4.0**}]	Configures the ATM UNI interface.

Example

The following example shows how to disable autoconfiguration on ATM interface 0/1/0 and configure the interface as the user side of a private UNI running version 4.0:

```
Switch(HB-1)(config)# interface atm 0/1/0
Switch(HB-1)(config-if)# no atm auto-configuration
Switch(HB-1)(config-if)#
%ATM-6-ILMINOAUTOCFG: ILMI(ATM0/1/0): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
Switch(HB-1)(config-if)# atm uni side user type private version 4.0
Switch(HB-1)(config-if)#
%ATM-5-ATMSOFTSTART: Restarting ATM signalling and ILMI on ATM0/1/0.
```

Displaying the UNI Interface Configuration

To show the UNI configuration for an ATM interface, use the following EXEC command:

Command	Purpose
show atm interface atm *card***/***subcard***/***port*[**.***vpt#*]	Shows the ATM interface configuration.

Example

The following example shows the ATM interface 0/1/0 UNI configuration:

```
Switch(HB-1)# show atm interface atm 0/1/0

Interface:      ATM0/1/0        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        Network         IF-type:        UNI
Uni-type:       private         Uni-version:    V4.0
<information deleted)
```

Configuring NNI Interfaces

The Network-Network Interface (NNI) specification defines communications between two ATM switches in a private ATM network.

You must configure NNI connections to allow for route discovery and topology analysis between the ATM switch routers. To configure the NNI interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm auto-configuration**	Disables autoconfiguration on the interface.
Step 3	Switch(config-if)# **atm nni**	Configures the ATM NNI interface.

Example

The following example shows how to configure ATM interface 3/0/0 as an NNI interface:

```
Switch(HB-1)(config)# interface atm 3/0/0
Switch(HB-1)(config-if)# no atm auto-configuration
Switch(HB-1)(config-if)#
%ATM-6-ILMINOAUTOCFG: ILMI(ATM3/0/0): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
Switch(HB-1)(config-if)# atm nni
Switch(HB-1)(config-if)#
%ATM-5-ATMSOFTSTART: Restarting ATM signalling and ILMI on ATM3/0/0.
```

Displaying the NNI Interface Configuration

To show the NNI configuration for an ATM interface, use the following EXEC command:

Command	Purpose
show atm interface atm *card***/***subcard***/***port*[**.***vpt#*]	Shows the ATM interface configuration.

Example

The following example shows the configuration of the NNI interface ATM 3/0/0 on the ATM switch router-1 (HB-1) located in the headquarters building:

```
Switch(HB-1)# show atm interface atm 3/0/0

Interface:      ATM3/0/0        Port-type:    oc3suni
IF Status:      UP              Admin Status: up
Auto-config:    disabled        AutoCfgState: not applicable
→ IF-Side:      Network         IF-type:      NNI
Uni-type:       not applicable  Uni-version:  not applicable

<information deleted>
```

Configuring a 12-Bit VPI NNI Interface (Catalyst 8540 MSR)

The Catalyst 8540 MSR ATM switch router can accommodate up to six interfaces per module for maxvpi-bits greater than the standard 8-bit configuration. If you try to configure more than the maximum number of allowed interfaces with 12-bit virtual path identifiers (VPIs), follow these precautions:

- When you must remove an interface (for example, hot-swapping a port adapter) that is configured for a maxvpi-bit, the number of interfaces (with maxvpi-bit value greater than 8) on the module is decremented. This allows you to then configure other interfaces on the same module for maxvpi-bits greater than eight bits.
- If a port adapter with interfaces configured with a maxvpi-bits value of eight is reinserted into a module location that previously held a port adapter with maxvpi-bits greater than eight bits, the VCs with VPIs greater than 255 remain in “No HW RESOURCES” state. An interface can be reconfigured to maxvpi-bits greater than eight, by changing the value to less than or equal to eight bits on a different interface. The VCs can be restored from “No HW RESOURCES” state by toggling the interface state using the **shutdown** and **no shutdown** commands.

When you need a 12-bit VPI range greater than 255, change the maximum VPI bits configuration. Perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm auto-configuration**	Disables autoconfiguration on the interface.
Step 3	Switch(config-if)# **atm nni**	Configures the ATM NNI interface.
Step 4	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.

Note 12-bit VPI support is only available on ATM NNI interfaces.

Example

The following example shows that if you are unable to configure a port with a maximum 12-bit VPI value greater than 8, you receive a message prompting you to reconfigure the port:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# no atm auto-configuration
Switch(config-if)# atm nni
Switch(config-if)# atm maxvpi-bits 12

This port can not be configured for vpi bits greater than 8, unless one
of the following ports is reconfigured for 8 bits vpi

interface a11/0/0
interface a11/0/1
interface a11/0/2
interface a11/0/3
interface a12/0/0
interface a12/0/1
```

Displaying the 12-Bit VPI NNI Interface Configuration (Catalyst 8540 MSR)

To display the 12-bit VPI NNI interface configuration, use the following EXEC commands:

Command	Purpose
show switch module interface atm *card/subcard/port*	Displays the maxvpi-bits for the specified ATM interface.
show atm interface atm *card/subcard/port*	Shows the ATM interface configuration.

Examples

The following example shows the maxvpi-bits for interface ATM 0/0/0:

```
Switch# show switch module interface atm 0/0/0
Module ID  Interface  Maxvpi-bits  State
----------------------------------------
0             ATM0/0/0   8            UP
              ATM0/0/4   8          DOWN
              ATM0/0/1   8          DOWN
              ATM0/0/5   8          DOWN
              ATM0/0/2   8            UP
              ATM0/0/6   8          DOWN
              ATM0/0/3   8            UP
              ATM0/0/7   8          DOWN
========================================
```

The following example shows how to display the configuration information for interface ATM 0/0/0:

```
Switch# show atm interface atm 0/0/0

Interface:      ATM0/0/0        Port-type:      oc3suni
IF Status:      DOWN            Admin Status:   down
Auto-config:    enabled         AutoCfgState:   waiting for response from peer
IF-Side:        Network         IF-type:        UNI
Uni-type:       Private         Uni-version:    V3.0
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 100             CurrMaxSvpcVpi: 100
ConfMaxSvccVpi: 100             CurrMaxSvccVpi: 100
ConfMinSvccVci: 60              CurrMinSvccVci: 60
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.0000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      3        0       0       0       0        0       0          3          0
Logical ports(VP-tunnels):     0
Input cells:    0               Output cells:   0
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 0, Output AAL5 pkts: 0, AAL5 crc errors: 0
```

Configuring IISP Interfaces

The Interim Interswitch Signalling Protocol (IISP) defines a static routing protocol for use between ATM switches. IISP provides support for switched virtual connections (SVCs) on switches that do not support the Private Network-Network Interface (PNNI) protocol. For further information, see Chapter 11, "Configuring ATM Routing and PNNI."

To configure an IISP interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm auto-configuration**	Disables autoconfiguration on the interface.
Step 3	Switch(config-if)# **atm iisp** [**side** {**network** | **user**}] [**version** {**3.0** | **3.1** | **4.0**}]	Configures the ATM IISP interface.
Step 4	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 5	Switch(config)# **atm route** *addr-prefix* **atm** *card***/***subcard***/***port*[**.***subinterface#*]	Configures the ATM route address prefix.

Example

The following example shows how to configure ATM interface 3/0/0 on the ATM switch router (SB-1) as user side IISP and specifies an ATM route address prefix:

```
Switch(SB-1)(config)# interface atm 3/0/0
Switch(SB-1)(config-if)# no atm auto-configuration
Switch(SB-1)(config-if)#
%ATM-6-ILMINOAUTOCFG: ILMI(ATM3/0/0): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
Switch(SB-1)(config-if)# atm iisp side user
Switch(SB-1)(config-if)#
%ATM-5-ATMSOFTSTART: Restarting ATM signalling and ILMI on ATM3/0/0.
Switch(SB-1)(config-if)# exit
Switch(SB-1)(config)# atm route 47.0091.8100.0000.0000.0ca7.ce01 atm 3/0/0
```

Displaying the IISP Configuration

To show the interface IISP configuration, use the following EXEC command:

Command	Purpose
show atm interface atm *card***/***subcard***/***port*[**.***vpt#*]	Shows the interface configuration.

Example

The following example shows the configuration of ATM interface 3/0/0 on the ATM switch router (SB-1):

```
Switch(SB-1)# show atm interface atm 3/0/0

Interface:      ATM3/0/0        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        User            IF-type:        IISP
Uni-type:       not applicable  Uni-version:    V3.0
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      3        0       0       0       0        0       0          3          2
Logical ports(VP-tunnels):     0
Input cells:    264089          Output cells:   273253
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 172421, Output AAL5 pkts: 176993, AAL5 crc errors: 0
```

Configuring Virtual Connections

This chapter describes how to configure virtual connections (VCs) in a typical ATM network after autoconfiguration has established the default network connections. The network configuration modifications described in this chapter are used to optimize your ATM network operation.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For an overview of virtual connection types and applications, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

The tasks to configure virtual connections are described in the following sections:

Characteristics and Types of Virtual Connections

This section lists the various virtual connections (VC) types in Table 7-1.

Table 7-1 Supported VC Types

Connection	Point-to-Point	Point-to-Multipoint	Transit	Terminate
Permanent virtual channel link (PVCL)	x	x	—	—
Permanent virtual path link (PVPL)	x	x	—	—
Permanent virtual channel (PVC)	x	x	x	x
Permanent virtual path (PVP)	x	x	x	—
Soft permanent virtual channel (Soft PVC)	x	x	x	x
Soft permanent virtual path (Soft PVP)	x	—	x	—
Switched virtual channel (SVC)	x	x	x	x
Switched virtual path (SVP)	x	x	x	—

Configuring Virtual Channel Connections

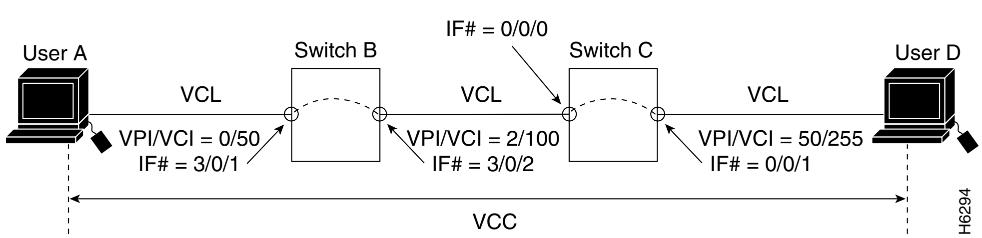
This section describes configuring virtual channel connections (VCCs) on the ATM switch router. A VCC is established as a bidirectional facility to transfer ATM traffic between two ATM layer users. Figure 7-1 shows an example VCC between ATM user A and user D.

An end-to-end VCC, as shown in Figure 7-1 between user A and user D, has two parts:

- Virtual channel links, labelled VCL. These are the interconnections between switches, either directly or through VP tunnels.
- Internal connections, shown by the dotted line in the switch. These connections are also sometimes called cross-connections or cross-connects.

The common endpoint between an internal connection and a link occurs at the switch interface. The endpoint of the internal connection is also referred to as a *connection leg* or *half-leg*. A cross-connect connects two legs together.

Figure 7-1 VCC Example



Note The value of the VPIs and VCIs can change as the traffic is relayed through the ATM network.

To configure a point-to-point VCC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm pvc** *vpi-A* [*vci-A* | **any-vci**[1]] [**rx-cttr** *index*] [**tx-cttr** *index*] [**wrr-weight** *weight*] [**sched** *sched-A*] **interface atm** *card/subcard/port*[**.***vpt#*] *vpi-B* [*vci-B* | **any-vci**[1]][**wrr-weight** *weight*] [**sched** *sched-B*]	Configures the PVC.

1. The **any-vci** parameter is only available for interface atm0.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note When configuring PVC connections, begin with lower VCI numbers. Using low VCI numbers allows more efficient use of the switch fabric resources.

Note This parameter specifies the weight assigned to the output VC for weighted round robin scheduling and is an integer in the range of 1 to 15.This parameter is valid only on systems equipped with the switch processor feature card. (Catalyst 8540 MSR and Catalyst 8510 MSR and LightStream 1010 with FC-PFQ). For more information on scheduling, see "Scheduling Output" in the *Guide to ATM Technology*.

Note The **sched** option is only available on OC-48c interfaces. Each OC-48c interface has four OC-12 schedulers. The sched variable is used to select the specific OC-12 scheduler for which the virtual circuit is assigned for output on an interface and is therefore a number between 1 and 4.

Examples

The following example shows how to configure the internal cross-connect PVC on Switch B between interface ATM 3/0/1 (VPI = 0, VCI = 50) and interface ATM 3/0/2 (VPI = 2, VCI = 100) (see Figure 7-1):

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm pvc 0 50 interface atm 3/0/2 2 100
```

The following example shows how to configure the internal cross-connect PVC on Switch C between interface ATM 0/0/0, VPI = 2, VCI = 100, and interface ATM 0/0/1, VPI 50, VCI = 255:

```
Switch-C(config)# interface atm 0/0/0
Switch-C(config-if)# atm pvc 2 100 interface atm 0/0/1 50 255
```

Each subsequent VC cross-connection and link must be configured until the VC is terminated to create the entire VCC.

Note The above examples show how to configure cross-connections using one command. This is the preferred method, but it is also possible to configure each leg separately, then connect them with the **atm pvc** *vpi vci* **interface atm** *card***/***subcard***/***port vpi vci* command. This alternative method requires more steps, but might be convenient if each leg has many additional configuration parameters or if you have configured individual legs with SNMP commands and you want to connect them with one CLI command.

Displaying VCCs

To show the VCC configuration, use the following EXEC commands:

Command	Purpose
show atm interface [**atm** *card***/***subcard***/***port*]	Shows the ATM interface configuration.
show atm vc [**interface atm** *card***/***subcard***/***port vpi vci*]	Shows the PVC interface configuration.

Note The following examples differ depending on the feature card installed on the processor.

Examples

The following example shows the Switch B PVC configuration on ATM interface 3/0/1:

```
Switch-B# show atm interface

Interface:      ATM3/0/1        Port-type:    oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   completed
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
ConfMaxVpiBits: 8               CurrMaxVpiBits: 8
ConfMaxVciBits: 14              CurrMaxVciBits: 14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      4        0       0       0       0        0       0          4          2
Logical ports(VP-tunnels):     0
Input cells:    264330          Output cells:   273471
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 172613, Output AAL5 pkts: 177185, AAL5 crc errors: 0
```

The following example shows the Switch B PVC configuration on ATM interface 3/0/1:

```
Switch-B# show atm vc interface atm 3/0/1
Interface    VPI   VCI   Type    X-Interface  X-VPI X-VCI  Encap Status
ATM3/0/1     0     5      PVC     ATM0          0     57    QSAAL  UP
ATM3/0/1     0     16     PVC     ATM0          0     37    ILMI   UP
ATM3/0/1     0     18     PVC     ATM0          0     73    PNNI   UP
ATM3/0/1     0     50     PVC     ATM3/0/2      2     100          UP
ATM3/0/1     1     50     PVC     ATM0          0     80    SNAP   UP
```

The following example shows the Switch B PVC configuration on ATM interface 3/0/1, VPI = 0, VCI = 50, with the switch processor feature card installed:

```
Switch-B# show atm vc interface atm 3/0/1 0 50

Interface: ATM3/0/1, Type: oc3suni
VPI = 0  VCI = 50
Status: UP
Time-since-last-status-change: 4d02h
Connection-type: PVC
Cast-type: point-to-point
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM3/0/2, Type: oc3suni
Cross-connect-VPI = 2
Cross-connect-VCI = 100
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Deleting VCCs from an Interface

This section describes how to delete a VCC configured on an interface. To delete a VCC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm pvc** *vpi vci*	Deletes the PVC.

Example

The following example shows how to delete the VCC on ATM interface 3/0/0, VPI = 20, VCI = 200:

```
Switch(config-if)# interface atm 3/0/0
Switch(config-if)# no atm pvc 20 200
Confirming VCC Deletion
```

To confirm the deletion of a VCC from an interface, use the following EXEC command before and after deleting the VCC:

Command	Purpose
show atm vc interface atm *card/subcard/port* [*vpi vci*]	Shows the PVCs configured on the interface.

Example

The following example shows how to confirm that the VCC is deleted from the interface:

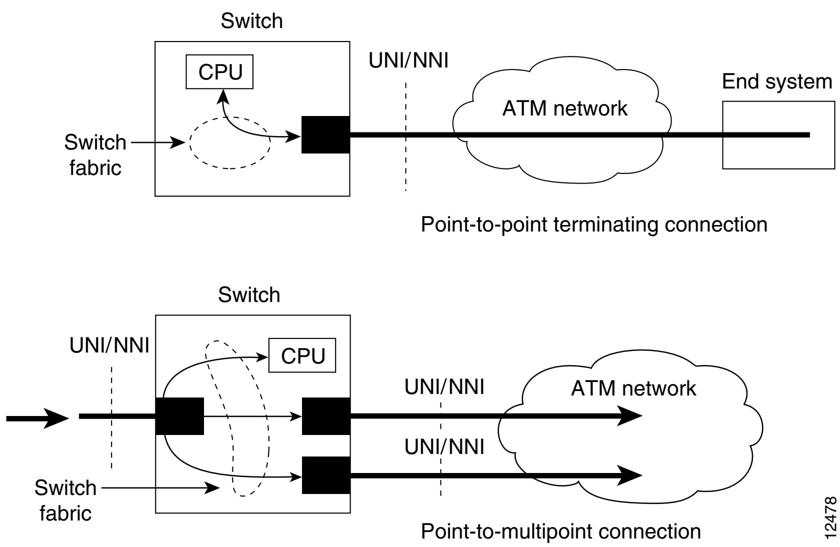
```
  Switch# show atm vc interface atm 3/0/0
  Interface         VPI  VCI   Type   X-Interface      X-VPI X-VCI Encap  Status
  ATM3/0/0          0    5     PVC    ATM2/0/0          0    77    QSAAL  UP
  ATM3/0/0          0    16    PVC    ATM2/0/0          0    55    ILMI   UP
  ATM3/0/0          0    18    PVC    ATM2/0/0          0    152   PNNI   UP
→ ATM3/0/0          0    34    PVC    ATM2/0/0          0    151   NCDP   UP
→ ATM3/0/0          20   200   PVC    ATM1/1/1          10   100          DOWN
  Switch# configure terminal
  Switch(config)# interface atm 3/0/0
  Switch(config-if)# no atm pvc 20 200
  Switch(config-if)# end
  Switch# show atm vc interface atm 3/0/0
  Interface         VPI  VCI   Type   X-Interface      X-VPI X-VCI Encap  Status
  ATM3/0/0          0    5     PVC    ATM2/0/0          0    77    QSAAL  UP
  ATM3/0/0          0    16    PVC    ATM2/0/0          0    55    ILMI   UP
  ATM3/0/0          0    18    PVC    ATM2/0/0          0    152   PNNI   UP
→ ATM3/0/0          0    34    PVC    ATM2/0/0          0    151   NCDP   UP
```

Configuring Terminating PVC Connections

This section describes configuring point-to-point and point-to-multipoint terminating permanent virtual channel (PVC) connections. Terminating connections provide the connection to the ATM switch router's route processor for LAN emulation (LANE), IP over ATM, and control channels for Integrated Local Management Interface (ILMI), signalling, and Private Network-Network Interface (PNNI) plus network management.

Figure 7-2 shows an example of transit and terminating connections.

Figure 7-2 Terminating PVC Types



Point-to-point and point-to-multipoint are two types of terminating connections. Both terminating connections are configured using the same commands as transit connections (discussed in the previous sections). However, all switch terminating connections use interface atm0 to connect to the route processor.

Note Since release 12.0(1a)W5(5b) of the system software, addressing the interface on the processor (CPU) has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. The old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

To configure both point-to-point and point-to-multipoint terminating PVC connections, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card-A/subcard-A/port-A*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm pvc** *vpi-A* [*vci-A* | **any-vci**[1]] [**cast-type** *type*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**wrr-weight** *weight*] [**sched** *sched-A*] **interface atm** *card-B/subcard-B/port-B*[.*vpt#*] *vpi-B* [*vci-B* | **any-vci**[1]] [**encap** *type*] [**cast-type** *type*] [**wrr-weight** *weight*] [**sched** *sched-B*]	Configures the PVC between ATM switch router connections.

1. The any-vci feature is only available for interface atm 0.

When configuring point-to-multipoint PVC connections using the **atm pvc** command, the root point is port A and the leaf points are port B.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note This parameter specifies the weight assigned to the output VC for weighted round robin scheduling and is an integer in the range of 1 to 15.This parameter is valid only on systems equipped with the switch processor feature card. (Catalyst 8540 MSR and Catalyst 8510 MSR and LightStream 1010 with FC-PFQ). For more information on scheduling, see "Scheduling Output" in the *Guide to ATM Technology*.

Note The **sched** option is only available on OC-48c interfaces. Each OC-48c interface has four OC-12 schedulers. The *sched* variable is used to select the specific OC-12 scheduler for which the virtual circuit is assigned for output on an interface and is therefore a number between 1 and 4.

Examples

The following example shows how to configure the internal cross-connect PVC between interface ATM 3/0/1, VPI = 1, VCI = 50, and the terminating connection at the route processor interface ATM 0, VPI = 0, and VCI unspecified:

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm pvc 1 50 interface atm0 0 any-vci encap aal5snap
```

The following example shows how to configure the route processor leg of any terminating PVC:

```
Switch(config)# interface atm0
Switch(config-if)# atm pvc 0 any-vci
```

When configuring the route processor leg of a PVC that is not a tunnel, the VPI should be configured as 0. The preferred method of VCI configuration is to select the **any-vci** parameter, unless a specific VCI is needed as a parameter in another command, such as **map-list**.

Note If configuring a specific VCI value for the route processor leg, select a VCI value higher than 300 to prevent a conflict with an automatically assigned VCI for well-known channels if the ATM switch router reboots.

Displaying the Terminating PVC Connections

To display the terminating PVC configuration VCs on the interface, use the following EXEC command:

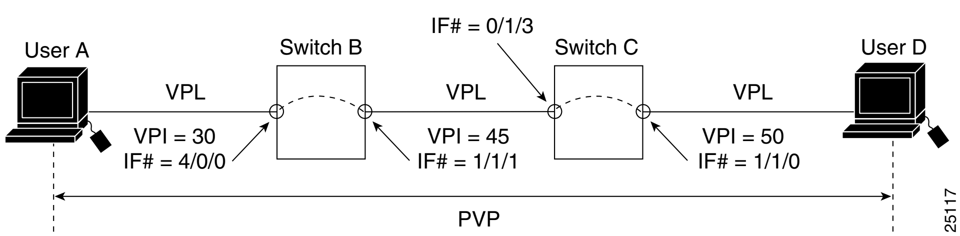
Command	Purpose
show atm vc interface atm *card/subcard/port vpi vci*	Shows the PVC configured on the interface.

See Displaying VCCs, page 7-4 for examples of the **show atm vc** commands.

Configuring PVP Connections

This section describes configuring a permanent virtual path (PVP) connection. Figure 7-3 shows an example of PVPs configured through the ATM switch routers.

Figure 7-3 Virtual Path Connection Example



To configure a PVP connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **atm pvp** *vpi-A* [**rx-cttr** *index*] [**tx-cttr** *index*] [**wrr-weight** *weight*] [**sched** *sched-A*] **interface atm** *card/subcard/port vpi-B* [**wrr-weight** *weight*] [**sched** *sched-B*]	Configures the interface PVP.

Note When configuring PVP connections, begin with lower virtual path identifier (VPI) numbers. Using low VPI numbers allows more efficient use of the switch fabric resources.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note This parameter specifies the weight assigned to the output VC for weighted round robin scheduling and is an integer in the range of 1 to 15.This parameter is valid only on systems equipped with the switch processor feature card. (Catalyst 8540 MSR and Catalyst 8510 MSR and LightStream 1010 with FC-PFQ). For more information on scheduling, see "Scheduling Output" in the Guide to ATM Technology.

Note The **sched** option is only available on OC-48c interfaces. Each OC-48c interface has four OC-12 schedulers. The sched variable is used to select the specific OC-12 scheduler for which the virtual circuit is assigned for output on an interface and is therefore a number between 1 and 4.

Examples

The following example shows how to configure the internal cross-connect PVP within Switch B between interfaces 4/0/0, VPI = 30, and interface ATM 1/1/1, VPI = 45:

```
Switch-B(config)# interface atm 4/0/0
Switch-B(config-if)# atm pvp 30 interface atm 1/1/1 45
```

The following example shows how to configure the internal cross-connect PVP within Switch C between interfaces 0/1/3, VPI = 45, and interface ATM 1/1/0, VPI = 50:

```
Switch-C(config)# interface atm 0/1/3
LS1010(config-if)# atm pvp 45 interface atm 1/1/0 50
```

Each subsequent PVP cross connection and link must be configured until the VP is terminated to create the entire PVP.

Displaying PVP Configuration

To show the ATM interface configuration, use the following EXEC command:

Command	Purpose
show atm vp [**interface atm** *card/subcard/port vpi*]	Shows the ATM VP configuration.

Example

The following example shows the PVP configuration of Switch B:

```
Switch-B# show atm vp
Interface    VPI    Type  X-Interface     X-VPI     Status
ATM1/1/1     45      PVP     ATM4/0/0     30        UP
ATM4/0/0     30      PVP     ATM1/1/1     45        UP
```

The following example shows the PVP configuration of Switch B with the switch processor feature card installed:

```
Switch-B# show atm vp interface atm 4/0/0 30

Interface: ATM4/0/0, Type: ds3suni
VPI = 30
Status: UP
Time-since-last-status-change: 00:09:02
Connection-type: PVP
Cast-type: point-to-point
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM1/1/1, Type: oc3suni
Cross-connect-VPI = 45
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Deleting PVPs from an Interface

This section describes how to delete a PVP configured on an interface. To delete a PVP, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm pvp** *vpi*	Deletes the PVP.

Example

The following example shows how to delete the PVP on ATM interface 1/1/0, VPI = 200:

```
Switch(config-if)# interface atm 1/1/0
Switch(config-if)# no atm pvp 200
```

Confirming PVP Deletion

To confirm the deletion of a PVP from an interface, use the following EXEC command before and after deleting the PVP:

Command	Purpose
show atm vp interface atm [*card/subcard/port vpi*]	Shows the PVCs configured on the interface.

Example

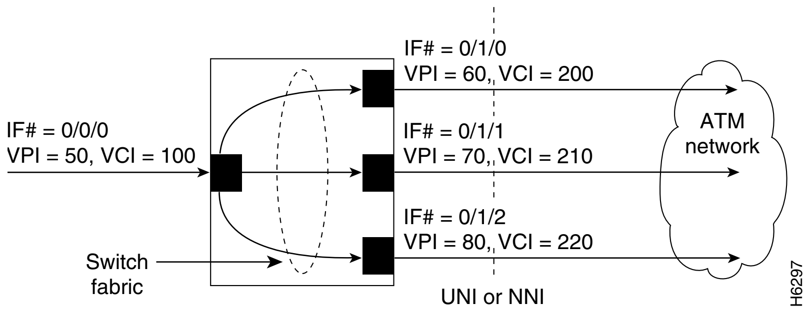
The following example shows how to confirm that the PVP is deleted from the interface:

```
Switch# show atm vp
Interface         VPI  Type  X-InterfaceX-VPI     Status
ATM1/1/0          113  PVP    TUNNEL
→ ATM1/1/0          200  PVP    ATM1/1/1100 DOWN
ATM1/1/1          1    PVP    SHAPED TUNNEL
→ ATM1/1/1          100  PVP    ATM1/1/0200 DOWN
Switch# configure terminal
Switch(config)# interface atm 1/1/0
Switch(config-if)# no atm pvp 200
Switch(config-if)# end
Switch# show atm vp
Interface         VPI  Type  X-InterfaceX-VPI     Status
ATM1/1/0          113  PVP    TUNNEL
ATM1/1/1          1    PVP    SHAPED TUNNEL
Switch#
```

Configuring Point-to-Multipoint PVC Connections

This section describes configuring point-to-multipoint PVC connections. In Figure 7-4, cells entering the ATM switch router at the root point (on the left side at interface ATM 0/0/0, VPI = 50, VCI = 100) are duplicated and switched to the leaf points (output interfaces) on the right side of the figure.

Figure 7-4 Point-to-Multipoint PVC Example



Note If desired, one of the leaf points can terminate in the ATM switch router at the route processor interface ATM 0.

To configure the point-to-multipoint PVC connections shown in Figure 7-4, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm pvc** *vpi-A vci-A* [**cast-type** *type-A*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**wrr-weight** *weight*] [**sched** *sched-A*] **interface atm** *card/subcard/port*[.*vpt#*] *vpi-B vci-B* [**cast-type** *type-B*] [**wrr-weight** *weight*] [**sched** *sched-B*]	Configures the PVC between ATM switch router connections.

To configure the point-to-multipoint PVC connections using the **atm pvc** command, the root point is port A and the leaf points are port B.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note This parameter specifies the weight assigned to the output VC for weighted round robin scheduling and is an integer in the range of 1 to 15.This parameter is valid only on systems equipped with the switch processor feature card. (Catalyst 8540 MSR and Catalyst 8510 MSR and LightStream 1010 with FC-PFQ). For more information on scheduling, see "Scheduling Output" in the *Guide to ATM Technology*.

Note The **sched** option is only available on OC-48c interfaces. Each OC-48c interface has four OC-12 schedulers. The *sched* variable is used to select the specific OC-12 scheduler for which the virtual circuit is assigned for output on an interface and is therefore a number between 1 and 4.

Examples

The following example shows how to configure the root-point PVC on ATM switch router interface ATM 0/0/0, VPI = 50, VCI = 100, to the leaf-point interfaces (see Figure 7-4):

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pvc 50 100 cast-type p2mp-root interface atm 0/1/0 60 200 cast-type
p2mp-leaf
Switch(config-if)# atm pvc 50 100 cast-type p2mp-root interface atm 0/1/1 70 210 cast-type
p2mp-leaf
Switch(config-if)# atm pvc 50 100 cast-type p2mp-root interface atm 0/1/2 80 220 cast-type
p2mp-leaf
```

Displaying Point-to-Multipoint PVC Configuration

To display the point-to-multipoint PVC configuration, use the following EXEC mode command:

Command	Purpose
show atm vc interface atm *card/subcard/port*	Shows the PVCs configured on the interface.
show atm vc interface atm *card/subcard/port vpi vci*	Shows the PVCs configured on the interface.

Examples

The following example shows the PVC configuration of the point-to-multipoint connections on ATM interface 0/0/0:

```
Switch# show atm vc interface atm 0/0/0
Interface         VPI   VCI    Type   X-Interface       X-VPI X-VCI Encap  Status
ATM0/0/0          0     5      PVC    ATM2/0/0           0     70   QSAAL  UP
ATM0/0/0          0     16     PVC    ATM2/0/0           0     46   ILMI   UP
ATM0/0/0          0     18     PVC    ATM2/0/0           0     120  PNNI   UP
ATM0/0/0          0     34     PVC    ATM2/0/0           0     192  NCDP   UP
ATM0/0/0          50    100    PVC    ATM0/1/0           60    200         UP
                                      ATM0/1/1           70    210         UP
                                      ATM0/1/2           80    220         UP
```

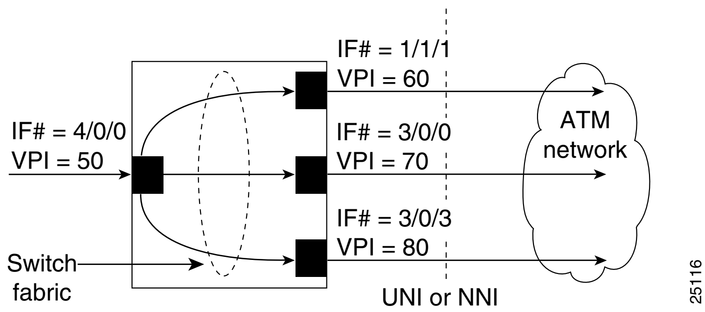
The following example shows the VC configuration on interface ATM 0/0/0, VPI = 50, VCI = 100, with the switch processor feature card installed:

```
Switch# show atm vc interface atm 0/0/0 50 100

Interface: ATM0/0/0, Type: oc3suni
VPI = 50  VCI = 100
Status: UP
Time-since-last-status-change: 00:07:06
Connection-type: PVC
Cast-type: point-to-multipoint-root
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/1/0, Type: oc3suni
Cross-connect-VPI = 60
Cross-connect-VCI = 200
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Cross-connect-interface: ATM0/1/1
Cross-connect-VPI = 70
Cross-connect-VCI = 210
Cross-connect-interface: ATM0/1/2
Cross-connect-VPI = 80
Cross-connect-VCI = 220
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Configuring Point-to-Multipoint PVP Connections

This section describes configuring point-to-multipoint PVP connections. Figure 7-5 provides an example of point-to-multipoint PVP connections.

Figure 7-5 Point-to-Multipoint PVP Example



In Figure 7-5, cells entering the ATM switch router at the root point (the left side at interface ATM 4/0/0), VPI = 50, are duplicated and switched to the leaf points (output interfaces), on the right side of the figure.

To configure point-to-multipoint PVP connections, perform the following steps, beginning in global configuration mode:

Command	Purpose
interface atm *card-A***/***subcard-A***/***port-A*	Selects the interface to be configured.

To configure the point-to-multipoint PVP connections using the **atm pvp** command, the root point is port A and the leaf points are port B.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Examples

The following example shows how to configure the root-point PVP on ATM switch router interface ATM 4/0/0 (VPI = 50), to the leaf point interfaces ATM 1/1/1 (VPI = 60), ATM 3/0/0 (VPI = 70), and ATM 3/0/3 (VPI = 80) (see Figure 7-5):

```
Switch(config)# interface atm 4/0/0
Switch(config-if)# atm pvp 50 cast-type p2mp-root interface atm 1/1/1 60 cast-type
p2mp-leaf
Switch(config-if)# atm pvp 50 cast-type p2mp-root interface atm 3/0/0 70 cast-type
p2mp-leaf
Switch(config-if)# atm pvp 50 cast-type p2mp-root interface atm 3/0/3 80 cast-type
p2mp-leaf
```

Displaying Point-to-Multipoint PVP Configuration

To display the ATM interface configuration, use the following EXEC command:

Command	Purpose
show atm vp [**interface atm** *card***/***subcard***/***port* *vpi*]	Shows the ATM VP configuration.

Examples

The following example shows the PVP configuration of the point-to-multipoint PVP connections on ATM interface 4/0/0:

```
Switch# show atm vp interface atm 4/0/0
Interface    VPI    Type  X-Interface     X-VPI     Status
ATM4/0/0     50      PVP     ATM1/1/1     60        UP
                             ATM3/0/0     70        UP
                             ATM3/0/3     80        UP
```

The following example shows the PVP configuration of the point-to-multipoint PVP connections on ATM interface 4/0/0, VPI = 50, with the switch processor feature card installed:

```
Switch# show atm vp interface atm 4/0/0 50

Interface: ATM4/0/0, Type: ds3suni
VPI = 50
Status: UP
Time-since-last-status-change: 00:01:51
Connection-type: PVP
Cast-type: point-to-multipoint-root
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM1/1/1, Type: oc3suni
Cross-connect-VPI = 60
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Cross-connect-interface: ATM3/0/0
Cross-connect-VPI = 70
Cross-connect-interface: ATM3/0/3
Cross-connect-VPI = 80
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

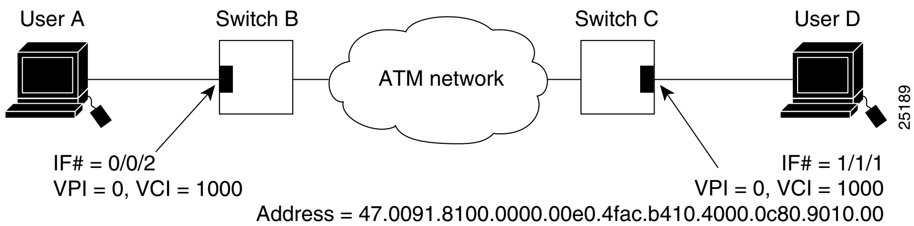
Configuring Soft PVC Connections

This section describes configuring soft permanent virtual channel (PVC) connections, which provide the following features:

- Connection to another host or ATM switch router that supports signalling
- Configuration of PVCs without the manual configuration steps described in Configuring Virtual Channel Connections, page 7-2
- Configuration of PVCs with the reroute or retry capabilities when a failure occurs in the network

Figure 7-6 illustrates the soft PVC connections used in the following examples.

Figure 7-6 Soft PCV Connection Example



Guidelines for Creating Soft PVCs

Perform the following steps when you configure soft PVCs:

Step 1 Determine which two ports you want to define as participants in the soft PVC.

Step 2 Decide which of these two ports you want to designate as the destination (or passive) side of the soft PVC.

This decision is arbitrary—it makes no difference which port you define as the destination end of the circuit.

Step 3 Retrieve the ATM address of the destination end of the soft PVC using the **show atm address** command.

Step 4 Retrieve the VPI/VCI values for the circuit using the **show atm vc** command.

Step 5 Configure the source (active) end of the soft PVC. At the same time, complete the soft PVC setup using the information derived from Step 3 and Step 4. Be sure to select an unused VPI/VCI value (one that does not appear in the **show atm vc** display).

Note To ensure that the soft PVCs are preserved during a route processor switchover, you must configure the switch to synchronize dynamic information between the route processors. For more information, see Chapter 3, "Initially Configuring the ATM Switch Router."

Configuring Soft PVCs

To configure a soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show atm addresses**	Determines the destination ATM address.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters configuration mode from the terminal.

	Command	Purpose
Step 3	Switch(config)# **interface atm** *card/subcard/port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 4	Switch(config-if)# **atm soft-vc** *source-vpi source-vci* **dest-address** *atm-address dest-vpi dest-vci* [**enable** | **disable**] [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *interval*] [**maximum** *interval*]] [**redo-explicit** [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**]] [**hold-priority** *priority*] [**timer-group** name]	Configures the soft PVC connection.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Examples

The following example shows the destination ATM address of the interface connected to User D:

```
Switch-C# show atm addresses

Switch Address(es):
  47.00918100000000400B0A2A81.00400B0A2A81.00 active
  47.00918100000000E04FACB401.00E04FACB401.00

Soft VC Address(es):

<Information deleted>

  47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9000.00 ATM1/1/0
  47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9010.00 ATM1/1/1
  47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9020.00 ATM1/1/2

<Information deleted>
```

The following example shows how to configure a soft PVC on Switch B between interface ATM 0/0/2, source VPI = 0, VCI = 1000; and Switch C, destination VPI = 0, VCI = 1000 with a specified ATM address (see Figure 7-6):

```
Switch-B(config)# interface atm 0/0/2
Switch-B(config-if)# atm soft-vc 0 1000 dest-address
47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9010.00 0 1000
```

Displaying Soft PVC Configuration

To display the soft PVC configuration at either end of a ATM switch router, use the following EXEC commands:

Command	Purpose
show atm vc interface atm *card/subcard/port*	Shows the VCs configured on the ATM interface.
show atm vc interface atm *card/subcard/port vpi vci*	Shows the soft PVC interface configuration.

Examples

The following example shows the soft PVC configuration of Switch B, on interface ATM 0/0/2 out to the ATM network:

```
Switch-B# show atm vc interface atm 0/0/2
Interface         VPI  VCI   Type   X-Interface      X-VPI X-VCI Encap  Status
ATM0/0/2          0    5     PVC    ATM0              0    45    QSAAL  UP
ATM0/0/2          0    16    PVC    ATM0              0    37    ILMI   UP
ATM0/0/2          0    18    PVC    ATM0              0    52    PNNI   UP
ATM0/0/2          0    34    PVC    ATM0              0    51    NCDP   UP
ATM0/0/2          0    35    SVC    ATM0/0/2          0    1000         UP
➔ ATM0/0/2        0    1000  SoftVC ATM0/0/2          0    35           UP
```

The following example shows the soft PVC configuration of Switch C, on interface ATM 1/1/1 out to the ATM network:

```
Switch-C# show atm vc interface atm 1/1/1
Interface         VPI  VCI   Type   X-Interface      X-VPI X-VCI Encap  Status
ATM1/1/1          0    5     PVC    ATM2/0/0          0    74    QSAAL  UP
ATM1/1/1          0    16    PVC    ATM2/0/0          0    44    ILMI   UP
ATM1/1/1          0    18    PVC    ATM2/0/0          0    109   PNNI   UP
ATM1/1/1          0    34    PVC    ATM2/0/0          0    120   NCDP   UP
ATM1/1/1          0    123   SVC    ATM1/1/1          0    1000         UP
➔ ATM1/1/1        0    1000  SoftVC ATM1/1/1          0    123          UP
ATM1/1/1          2    100   PVC    ATM2/0/0          0    103   SNAP   UP
```

The following example shows the soft PVC configuration of Switch B, on interface ATM 0/0/2 (VPI = 0, VCI = 1000) out to the ATM network with the switch processor feature card installed:

```
Switch-B# show atm vc interface atm 0/0/2 0 1000

Interface: ATM0/0/2, Type: oc3suni
→ VPI = 0  VCI = 1000
Status: UP
Time-since-last-status-change: 21:56:48
Connection-type: SoftVC
Cast-type: point-to-point
 Soft vc location: Source
→ Remote ATM address: 47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.9010.00
 Remote VPI: 0
 Remote VCI: 1000
 Soft vc call state: Active
 Number of soft vc re-try attempts: 0
 First-retry-interval: 5000 milliseconds
 Maximum-retry-interval: 60000 milliseconds
 Aggregate admin weight: 10080
 TIME STAMPS:
 Current Slot:2
  Outgoing Setup     May 25 10:38:50.718
  Incoming Connect   May 25 10:38:50.762

Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/0/2, Type: oc3suni
Cross-connect-VPI = 0
Cross-connect-VCI = 35
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Modifying CTTR Indexes on an Existing Soft PVC

To change the CTTR indexes and PD (packet discard option) on an existing soft PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port*	Selects the interface being configured.
Step 2	Switch(config-if)# **atm soft-vc** *source-vpi source-vci* [**rx-cttr** *index*] [**tx-cttr** *index*] [**pd** {**off** | **on** | **use-cttr**}]	Specifies the new PD option for the existing soft l along with the new receive and transmit CTTR indexes.
Step 3	Switch(config-if)# **end** Switch#	Switches to EXEC command mode.

Examples

The following example modifies the CTTR indexes for an existing soft PVC.

```
Switch(config)# interface atm 1/1/1
Switch(config-if)# atm soft-vc 25 48 rx-cttr 102 tx-cttr 102
Switch(config-if)# end
Switch#
```

The following example modifies the packet discard option to On for an existing soft PVC.

```
Switch(config)# intertace atm 0/0/3
Switch(config-if)# atm soft-vc 8 990 pd on

The following example displays the packet-discard-option as enabled for the soft PVC
configured on ATM interface 0/0/3.
Switch# show atm vc interface atm 0/0/3 8 990

Interface: ATM0/0/3, Type: oc3suni
VPI = 8  VCI = 990
Status: UP
Time-since-last-status-change: 00:00:22
Connection-type: SoftVC
Cast-type: point-to-point
Hold-priority: none
 Soft vc location: Source
 Remote ATM address: 47.0091.8100.0011.0050.e202.9f01.4000.0c80.1000.00
 Remote VPI: 8
 Remote VCI: 990
 Soft vc call state: Active
 Number of soft vc re-try attempts: 0
 First-retry-interval: 5000 milliseconds
 Maximum-retry-interval: 60000 milliseconds
 Aggregate admin weight: 5040
 TIME STAMPS:
 Current Slot:0
  Outgoing Setup     December 11 02:05:43.535
  Incoming Connect   December 11 02:05:43.555
  Outgoing Release   December 11 02:07:34.891
  Incoming Rel comp  December 11 02:07:34.891

→ Packet-discard-option: enabled
 Usage-Parameter-Control (UPC): pass
 Wrr weight: Not-applicable
 Number of OAM-configured connections: 60
 OAM-configuration: disabled
 OAM-states:  Not-applicable
 Cross-connect-interface: ATM0/1/0, Type: oc12suni
 Cross-connect-VPI = 0
 Cross-connect-VCI = 37
 Cross-connect-UPC: pass
 Cross-connect OAM-configuration: disabled
 Cross-connect OAM-state:  Not-applicable
 Threshold Group: 1, Cells queued: 0
 Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx pkts:0, Rx pkt drops:0
Rx connection-traffic-table-index: 444
Rx service-category: CBR (Constant Bit Rate)
Rx pcr-clp01: 256
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 444
Tx service-category: CBR (Constant Bit Rate)
Tx pcr-clp01: 256
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

The following example modifies the packet discard option to Off for an existing soft PVC.

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# atm soft-vc 8 990 pd off
```

The following example specifies different receive and transmit CTTR indexes and PD option for an existing soft PVC.

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# atm soft-vc 8 990 rx-cttr 444 tx-cttr 444 pd off
```

The following example displays the receive and transmit CTTR indexes and packet-discard-option for the soft PVC configured on ATM interface 0/0/3.

```
Switch# show atm connection-traffic-table 444
Row       Service-category    pcr        scr/mcr       mbs          cdvt    pd
444           cbr             256                                   none   off
```

The following example specifies the CTTR index and specifies the PD use the PD option specified in the CTTR index.

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# atm soft-vc 8 990 rx-cttr 444 tx-cttr 444 pd use-cttr
```

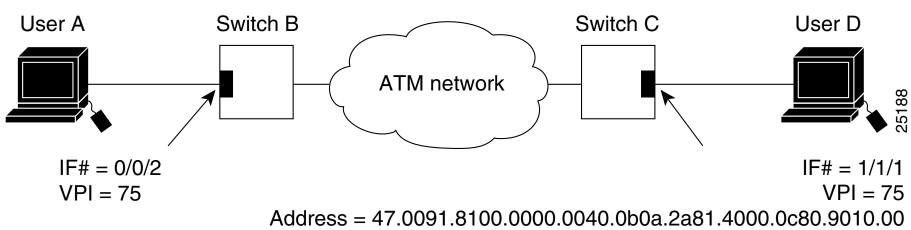
Configuring Soft PVP Connections

This section describes configuring soft permanent virtual path (PVP) connections, which provide the following features:

- Connection to another host or ATM switch router that does supports signalling
- Configuration of PVPs without the manual configuration steps described in the "Configuring Virtual Channel Connections" section on page 2.
- Configuration of PVPs with the reroute or retry capabilities when a failure occurs within the network

Figure 7-7 is an illustration of the soft PVP connections used in the examples in this section.

Figure 7-7 Soft PVP Connection Example



To configure a soft PVP connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm soft-vp** *source-vpi* **dest-address** *atm-address dest-vpi* [**enable** | **disable**] [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *interval*] [**maximum** *interval*]] [**redo-explicit** [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**]] [**hold-priority** *priority*] [**timer-group** name]	Configures the soft PVP connection.

The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See the Chapter 9, "Configuring Resource Management.".

Example

The following example shows how to configure a soft PVP on Switch B between interface ATM 0/0/2, source VPI = 75; and Switch C, destination VPI = 75, with a specified ATM address (see Figure 7-7):

```
Switch-B(config)# interface atm 0/0/2
Switch-B(config-if)# atm soft-vp 75 dest-address
47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.9010.00 75
```

Displaying Soft PVP Connections

To display the ATM soft PVP configuration, use the following EXEC command:

Command	Purpose
show atm vp [**interface atm** *card/subcard/port vpi*]	Shows the soft PVP configuration.

Examples

The following example shows the soft PVP configuration at Switch B, on interface ATM 0/0/2 out to the ATM network:

```
Switch-B# show atm vp
Interface         VPI  Type  X-Interface          X-VPI     Status
ATM0/0/2          1    SVP    ATM0/0/2           75   UP
ATM0/0/2          75   SoftVP ATM0/0/2           1    UP
```

The following example shows the soft PVP configuration on interface ATM 1/1/1 at Switch C out to the ATM network:

```
Switch-C# show atm vp
Interface         VPI  Type  X-Interface         X-VPI     Status
ATM1/1/1          1    SVP    ATM1/1/1          75  UP
ATM1/1/1          75   SoftVP ATM1/1/1          1   UP
```

The following example shows the soft PVP configuration at Switch B on interface ATM 0/0/2 (VPI = 75) out to the ATM network with the switch processor feature card installed:

```
Switch-B# show atm vp interface atm 0/0/2 75

Interface: ATM0/0/2, Type: oc3suni
➔ VPI = 75
Status: UP
Time-since-last-status-change: 00:09:46
Connection-type: SoftVP
Cast-type: point-to-point
 Soft vp location: Source
➔ Remote ATM address: 47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.9010.00
 Remote VPI: 75
 Soft vp call state: Active
 Number of soft vp re-try attempts: 0
 First-retry-interval: 5000 milliseconds
 Maximum-retry-interval: 60000 milliseconds
 Aggregate admin weight: 10080
 TIME STAMPS:
 Current Slot:2
  Outgoing Setup     May 26 09:45:30.292
  Incoming Connect   May 26 09:45:30.320
<information deleted>
```

Modifying CTTR Indexes on an Existing Soft PVP

To change the CTTR indexes on an existing Soft PVP, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port*	Selects the interface being configured.
Step 2	Switch(config-if)# **atm soft-vp** *source-vpi* [**rx-cttr** *index*] [**tx-cttr** *index*]	Specifies the new **rx-cttr** and **tx-cttr** indexes for existing Soft PVP.
Step 3	Switch(config-if)# **end** Switch#	Switches to EXEC command mode.

Example

The following example modifies the CTTR indexes for an existing Soft PVP.

```
Switch(config)# interface atm 1/1/1
Switch(config-if)# atm soft-vp 48 rx-cttr 102 tx-cttr 102
Switch(config-if)# end
Switch#
```

Configuring the Soft PVP or Soft PVC Route Optimization Feature

This section describes the soft PVP or soft PVC route optimization feature. Most soft PVPs or soft PVCs have a much longer lifetime than SVCs. The route chosen during the soft connection setup remains the same even though the network topology might change.

Soft connections, with the route optimization percentage threshold set, provide the following features:

- When a better route is available, soft PVPs or PVCs are dynamically rerouted
- Route optimization can be triggered manually

Note Soft PVC route optimization should not be configured with constant bit rate (CBR) connections.

Route optimization is directly related to administrative weight, which is similar to hop count. For a description of administrative weight, see Chapter 11, "Configuring ATM Routing and PNNI."

Configuring soft PVP or soft PVC route optimization is described in the following sections:

- Enabling Soft PVP or Soft PVC Route Optimization, page 7-29
- Configuring a Soft PVP/PVC Interface with Route Optimization, page 7-29

For overview information about the route optimization feature refer to the *Guide to ATM Technology*.

Enabling Soft PVP or Soft PVC Route Optimization

Soft PVP or soft PVC route optimization must be enabled and a threshold level configured to determine the point when a better route is identified and the old route is reconfigured.

To enable and configure route optimization, use the following global configuration command:

Command	Purpose
atm route-optimization percentage-threshold *percent*	Configures route optimization.

Example

The following example enables route optimization and sets the threshold percentage to 85 percent:

```
Switch(config)# atm route-optimization percentage-threshold 85
Configuring a Soft PVP/PVC Interface with Route Optimization
```

Soft PVP or soft PVC route optimization must be enabled and configured to determine the point at which a better route is found and the old route is reconfigured.

To enable and configure a soft PVC/PVP interface with route optimization, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface** [**atm** *card*/*subcard*/*port* | **serial** *card*/*subcard*/*port*:*cgn*] Switch(config-if)#	Selects the interface to configure. Enter the interface number of the source end of the soft PVC/PVP. Route optimization works for the source end of a soft PVC/PVP only and is ignored if configured on the destination interface.
Step 2	Switch(config-if)# **atm route-optimization soft-connection** [**interval** *minutes*] [**time-of-day** {**anytime** | *start-time end-time*}]	Configures the interface for route optimization.

Example

The following example shows how to configure an interface with a route optimization interval configured as every 30 minutes between the hours of 6:00 P.M. and 5:00 A.M.:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm route-optimization soft-connection interval 30 time-of-day 18:00
5:00
```

Displaying an Interface Route Optimization Configuration

To display the interface route optimization configuration, use the following EXEC command:

Command	Purpose
show atm interface [**atm** *card*/*subcard*/*port* | **serial** *card*/*subcard*/*port*:*cgn*]	Shows the interface configuration route optimization configuration.

Example

The following example shows the route optimization configuration of ATM interface 0/0/0:

```
Switch# show atm interface atm 0/0/0
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   completed
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
ConfMaxVpiBits: 8               CurrMaxVpiBits: 8
ConfMaxVciBits: 14              CurrMaxVciBits: 14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
→ Soft vc route optimization is enabled
→ Soft vc route optimization interval = 30 minutes
→ Soft vc route optimization time-of-day range = (18:0 - 5:0)
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
<information deleted>
```

Configuring Soft PVCs with Explicit Paths

Normally, soft PVCs and soft PVPs are automatically routed by PNNI over paths that meet the traffic parameter objectives. However, for cases where manually configured paths are needed, PNNI explicit paths can optionally be specified for routing the soft PVC or soft PVP. For detailed information on configuring PNNI explicit paths, see Chapter 11, "Configuring ATM Routing and PNNI."

The explicit paths are assigned using precedence numbers 1 through 3. The precedence 1 path is tried first and if it fails the soft connection is routed using the precedence 2 path and so forth. If all of the explicit paths fail, standard on-demand PNNI routing is tried unless the **only-explicit** keyword is specified.

If the soft connection destination address is reachable at one of the included entries in an explicit path, any following entries in that path are automatically disregarded. This allows longer paths to be reused for closer destinations. Alternatively, the **upto** keyword can be specified for an explicit path in order to disregard later path entries.

Example

The following example shows how to configure a soft PVC between ATM switch router dallas_1 and an address on ATM switch router new_york_3 using either of the two explicit paths new_york.path1 and new_york.path2. If both explicit paths fail, the ATM switch router uses PNNI on-demand routing to calculate the route.

```
dallas_1(config)# interface atm 0/0/0
dallas_1(config)# atm soft-vc 0 201 dest-address
47.0091.8100.0000.1061.3e7b.2f99.4000.0c80.0030.00 0 101 explicit-path 1 name
new_york.path1 explicit-path 2 name new_york.path2
```

Changing Explicit Paths for an Existing Soft PVC

Explicit paths can be added, modified or removed without tearing down existing soft PVCs by using the **redo-explicit** keyword. Only the source VPI and VCI options need to be specified. All applicable explicit path options are replaced by the respecified explicit path options.

The soft PVC is not immediately rerouted using the new explicit path. However, reroutes using the new explicit path can happen for the following four reasons:

1. A failure occurs along the current path.
2. The EXEC command **atm route-optimization soft-connection** is entered for the soft PVC.
3. **route-optimization** is enabled and the retry time interval has expired.
4. The soft PVC is disabled and then reenabled using the **disable** and **enable** keywords.

Example

The following example shows how to change the explicit path configuration for an existing soft PVC on the ATM switch router dallas_1 without tearing down the connection. The new configuration specifies the two explicit paths, new_york.path3 and new_york.path4, and uses the only-explicit option.

```
dallas_1(config)# interface atm 0/0/0
dallas_1(config)# atm soft-vc 0 201 redo-explicit explicit-path 1 name new_york.path3
explicit-path 2 name new_york.path4 only-explicit
```

Note The configuration displayed for soft connections with explicit paths is always shown as two separate lines using the **redo-explicit** keyword on the second line, even if it is originally configured using a single command line.

Displaying Explicit Path for Soft PVC Connections

To display a soft PVC connection successfully routed over an explicit path, use the following EXEC command:

Command	Purpose
show atm vc interface atm *card/subcard/port vpi vci*	Displays the soft PVC connection status including the PNNI explicit path routing status for the last setup attempt.

Example

The following example shows the last explicit path status for a soft PVC using the **show atm vc interface** EXEC command. Note that the first listed explicit path new_york.path2 shows an unreachable result, but the second explicit path new_york.path1 succeeded.

```
Switch# show atm vc interface atm 0/1/3 0 40
VPI = 0  VCI = 40
Status:UP
Time-since-last-status-change:00:00:03
Connection-type:SoftVC
Cast-type:point-to-point
 Soft vc location:Source
 Remote ATM address:47.0091.8100.0000.0060.705b.d900.4000.0c81.9000.00
 Remote VPI:0
 Remote VCI:40
 Soft vc call state:Active
 Number of soft vc re-try attempts:0
 First-retry-interval:5000 milliseconds
 Maximum-retry-interval:60000 milliseconds
 Aggregate admin weight:15120
 TIME STAMPS:
 Current Slot:4
  Outgoing Release   February 26 17:02:45.940
  Incoming Rel comp  February 26 17:02:45.944
  Outgoing Setup     February 26 17:02:45.948
  Incoming Connect   February 26 17:02:46.000
  Outgoing Setup     February 23 11:54:17.587
  Incoming Release   February 23 11:54:17.591
  Outgoing Setup     February 23 11:54:37.591
  Incoming Release   February 23 11:54:37.611
  Outgoing Setup     February 23 11:55:17.611
  Incoming Connect   February 23 11:55:17.655

→ Explicit-path 1:result=6  PNNI_DEST_UNREACHABLE  (new_york.path2)
→ Explicit-path 2:result=1  PNNI_SUCCESS  (new_york.path1)
 Only-explicit
Packet-discard-option:disabled
Usage-Parameter-Control (UPC):pass
Number of OAM-configured connections:0
OAM-configuration:disabled
OAM-states: Not-applicable
Cross-connect-interface:ATM0/0/3.4, Type:oc3suni
Cross-connect-VPI = 4
Cross-connect-VCI = 35
Cross-connect-UPC:pass
Cross-connect OAM-configuration:disabled
Cross-connect OAM-state: Not-applicable
Rx cells:0, Tx cells:0
Rx connection-traffic-table-index:1
Rx service-category:UBR (Unspecified Bit Rate)
Rx pcr-clp01:7113539
Rx scr-clp01:none
Rx mcr-clp01:none
Rx      cdvt:1024 (from default for interface)
Rx       mbs:none
Tx connection-traffic-table-index:1
Tx service-category:UBR (Unspecified Bit Rate)
Tx pcr-clp01:7113539
Tx scr-clp01:none
Tx mcr-clp01:none
Tx      cdvt:none
Tx       mbs:none
```

Configuring Soft PVCs and Soft PVPs with Priority

This section describes how to specify priority for soft PVCs or PVPs established over an Inverse Multiplexing for ATM (IMA) interface. If an IMA link goes down, the performance of all virtual connections requesting guaranteed bandwidth (CBR, VBR-RT/NRT, ABR/UBR+ with nonzero MCR) can be adversely affected. By configuring the priority for soft PVCs or PVPs, connections with the highest priority are more likely to be preserved if an IMA link goes down, while connections with lower or no priorities are cleared, thereby maintaining bandwidth for the most important connections. A priority of 0 (highest) to 15 (lowest) can be specified for each soft PVC.

Note Connections of the highest priority may be randomly chosen for clearing if insufficient bandwidth is available.

If an IMA link goes down, a check is made to see whether the reduced interface bandwidth is greater than that allocated to connections. If the available bandwidth is below that allocated, the qualifying signaled VCs are checked to see if they have allocated guaranteed bandwidth. If signaled VCs have allocated guaranteed bandwidth, they are released on a priority basis until either the bandwidth allocated is less than that available, or there are no guaranteed-bandwidth signaled VCs.

Note A signaled VC must have allocated bandwidth in order to be released by priority. Therefore, simple UBR VCs cannot be released by priority. UBR+ VCs, however, have allocated bandwidth and can therefore be released by priority.

Note Though unaffected by priority configuration, the bandwidth allocated by PVCs is considered when determining whether or not the bandwidth allocated is below that available.

To specify that soft PVCs can be cleared by priority, perform the following task on an IMA interface:

Command	Purpose
Switch(config-if)# **atm svc-clear by-priority**	Specifies that soft PVCs can be cleared based on priority configurations when bandwidth is reduced on an IMA interface.

Configuring a Soft PVC with priority

To configure a soft PVC with priority, perform the following steps:

	Command	Purpose
Step 1	Switch(config-if)# **atm soft-vc** *source-vpi source-vci* **dest-address** *atm-address dest-vpi dest-vci* [**enable | disable**] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]] [**hold-priority** *priority*]	Creates a soft PVC with a priority from 0 (high) to 15 (low).

	Command	Purpose
Step 2	Switch(config-if)# **end**	Switches to EXEC command mode.
Step 3	Switch# **show atm vc interface atm** *card/subcard/port vpi vci*	Displays the soft PVC configuration information, including the holding priority.

Note If not priority is specified, the soft PVC is assigned a priority of 15 (lowest).

Note If the **atm svc-clear by-priority** command is not enabled, none of the hold-priority configurations are considered when bandwidth is dropped on an interface.

Configuring a Soft PVP with Priority

To configure a soft PVP with priority, perform the following steps:

	Command	Purpose
Step 1	Switch(config-if)# **atm soft-vp** *vpi vci* **dest-address** *nsap vpi* [**hold-priority** *priority*]	Creates a soft PVP with a priority from 0 (high) to 15 (low).
Step 2	Switch(config-if)# **end**	Switches to EXEC command mode.
Step 3	Switch# **show atm vp interface atm** *card/subcard/port vpi vci*	Displays the soft PVP configuration information, including the holding priority.

Configuring a Soft PVC with Priority for a CES Circuit

To configure a soft PVC with priority for a circuit emulation service (CES) circuit, use the following command:

Command	Purpose
Switch(config-if)# **ces pvc** 1 **dest-address** *nsap* **vpi** *vci* **vci** *vci* [**hold-priority** *priority*]	Configures a soft PVC with priority on a CES circuit.

Configuring a Soft PVC with Priority for Frame Relay Connections

To configure a soft PVC with priority between a Frame Relay connection and an ATM connection, use the following command:

Command	Purpose
Switch(config-if)# **frame-relay soft-vc** *dlci* **dest-address** *nsap* **vc** *vpi vci* [**hold-priority** *priority*]	Configures a soft PVC with priority between a frame relay connection and an ATM connection.

To configure a soft PVC with priority between two Frame Relay connections, use the following command:

Command	Purpose
Switch(config-if)# **frame-relay soft-vc** *dlci* **dest-address** *nsap* **dlci** *dlci* [**hold-priority** *priority*]	Configures a soft PVC with priority between two Frame Relay connections.

To display a soft PVC with priority, use the following command:

Command	Purpose
Switch# **show atm vp interface atm** *card/subcard/port vpi vci*	Displays the a soft PVC with priority configuration information.

Example

The following example shows the configuration of a soft PVC with priority on an IMA interface.

```
Switch(config)# interface atm4/1/ima1
Switch(config-if)# atm svc-clear by-priority
Switch# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm0/0/0
Switch(config-if)# atm soft-vc 0 104 dest-address
47.0091.8100.0000.0060.3e64.fd01.4000.0c82.0000.00  0 104 rx 1000 tx 1000 hold 10
Switch(config-if)# end
Switch#
Switch# show atm vc interface atm 0/0/0 0 104

Interface:ATM0/0/0, Type:oc3suni
VPI = 0  VCI = 104
Status:UP
Time-since-last-status-change:00:00:42
Connection-type:SoftVC
Cast-type:point-to-point
Hold-priority:10
 Soft vc location:Source
 Remote ATM address:47.0091.8100.0000.0060.3e64.fd01.4000.0c82.0000.00
 Remote VPI:0
 Remote VCI:104
 Soft vc call state:Active
 Number of soft vc re-try attempts:0
 First-retry-interval:5000 milliseconds
 Maximum-retry-interval:60000 milliseconds
 Aggregate admin weight:5040
 TIME STAMPS:
 Current Slot:2
  Outgoing Setup     August 24 15:50:04.531
  Incoming Connect   August 24 15:50:04.575

Packet-discard-option:disabled
Usage-Parameter-Control (UPC):pass
Wrr weight:2
Number of OAM-configured connections:0
OAM-configuration:disabled
OAM-states: Not-applicable
Cross-connect-interface:ATM4/1/ima1, Type:imapam_t1_ima
Cross-connect-VPI = 0
Cross-connect-VCI = 47
Cross-connect-UPC:pass
Cross-connect OAM-configuration:disabled
Cross-connect OAM-state: Not-applicable
Threshold Group:1, Cells queued:0
Rx cells:0, Tx cells:0
Tx Clp0:0,  Tx Clp1:0
Rx Clp0:0,  Rx Clp1:0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index:1000
Rx service-category:CBR (Constant Bit Rate)
Rx pcr-clp01:1000
Rx scr-clp01:none
Rx mcr-clp01:none
Rx      cdvt:1024 (from default for interface)
Rx       mbs:none
Tx connection-traffic-table-index:1000
Tx service-category:CBR (Constant Bit Rate)
Tx pcr-clp01:1000
```

```
Tx scr-clp01:none
Tx mcr-clp01:none
Tx       cdvt:none
Tx        mbs:none
```

Configuring Two-Ended Soft PVC and Soft PVP Connections

With two-ended soft PVC provisioning, you can configure a passive half leg on the terminating switch of a soft PVC. This allows resources on the terminating switch to be reserved for the incoming soft PVC. Also, the UPC option can be configured for an individual soft PVC allowing traffic policing.

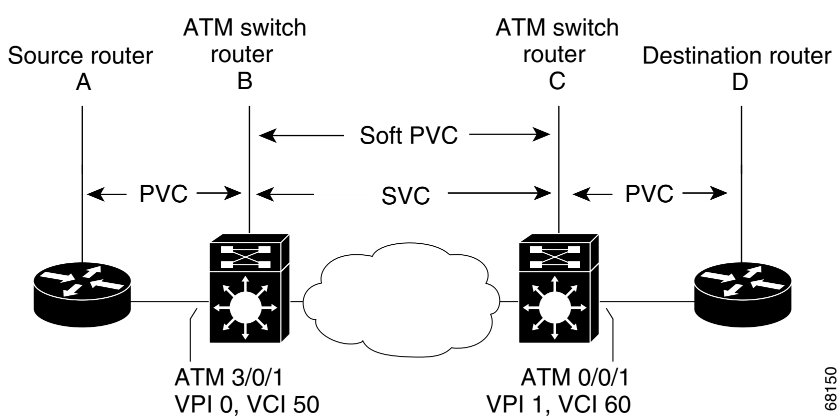
You can configure the passive half-leg (using the two-ended soft PVC feature) with the following parameters:

- Packet discard
- A connection traffic table row associated with the half leg
- Usage Parameter Control

The passive leg is used provided the traffic parameters of the leg match with the incoming connection setup request and the leg is in a “Not Connected” state. If the passive leg is not pre-configured, the default values are used when creating the dynamic leg.

Figure 7-8 shows a soft PVC between ATM switch routers and PVCs configured on both ends connecting the routers. In this example the passive half-leg is configured at the destination end at ATM switch router C.

Figure 7-8 Two-Ended Soft PVC Configuration Example



Configuring Two-Ended Soft PVC Connections

To configure a two-ended soft PVC connection, follow these steps:

.

	Command	Purpose
Step 1	Switch-C(config)# **atm filter-set** *name* [**index** [*number*]] [**permit** | **deny**] [*template* | **time-of-day** {**anytime** | *start-time* {*end-time*}}]	(Optional) Used to configure the **access-control filter-set** parameter in on the passive destination-side of the soft VC.
Step 2	Switch-C(config)# **interface atm** *card/subcard/port* Switch-C(config-if)#	Selects the interface, on the terminating switch, being configured.
Step 3	Switch-C(config-if)# **atm soft-vc** *dest-vpi dest-vci* **passive** [**pd** *pd*] [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**access-control** {**src-address** *atm-address* | **filter-set** *name*}]	Configures the passive leg on the terminating switch interface.
Step 4	Switch-B(config-if)# **atm soft-vc** *source-vpi source-vci* **dest-address** *atm-address dest-vpi dest-vci* [**enable** | **disable**] [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Creates a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.
Step 5	Switch-C(config-if)# **end**	Switches to EXEC command mode.
Step 6	Switch-C# **show atm vc interface atm** *card/subcard/port vpi vci*	Displays the passive half-leg configuration information of two-ended soft PVC.

Note The default value for the **upc** option is *pass*.

Note The default value for the **pd** option is *use-cttr*.

Note For VBR-nrt and VBR-rt service categories you must configure the MBS (even if the value is default) in the ATM connection traffic table row attached to the passive leg.

Note You can use the **debug atm sig-soft (interface)** and **debug atm rm events** commands to get information on why a passive leg is not used due to traffic parameter mismatches.

Configuring Two-Ended Soft PVP Connections

To configure a two-ended soft PVP connection, follow these steps:

	Command	Purpose
Step 1	Switch-C(config)# **atm filter-set** *name* [**index** [*number*]] [**permit** | **deny**] [*template* | **time-of-day** {**anytime** | *start-time* {*end-time*}}]	(Optional) Used to configure the **access-control filter-set** parameter on the passive destination-side of the soft VP.
Step 2	Switch-C(config)# **interface atm** *card/subcard/port* Switch-C(config-if)#	Selects the interface, on the terminating switch, being configured.
Step 3	Switch-C(config-if)# **atm soft-vp** *dest-vpi* **passive** [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**access-control** {**src-address** *atm-address* | **filter-set** *name*}]	Configures the passive leg on the terminating switch interface.
Step 4	Switch-B(config-if)# **atm soft-vp** *source-vpi* **dest-address** *atm-address dest-vpi* [**enable** | **disable**] [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Creates a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.
Step 5	Switch-C(config-if)# **end**	Switches to EXEC command mode.
Step 6	Switch-C# **show atm vp interface atm** *card/subcard/port vpi*	Displays the passive half-leg configuration information of two-ended soft PVP.

Note The default value for the **upc** option is *pass*.

Note For VBR-nrt and VBR-rt service categories you must configure the MBS (even if the value is default) in the ATM connection traffic table row attached to the passive leg.

Note You can use the **debug atm sig-soft (interface)** and **debug atm rm events** commands to get information on why a passive leg is not used due to traffic parameter mismatches.

Examples

The following example shows the configuration of the two-ended soft PVC (shown in Figure 7-8) with a passive half leg starting with the configuration of Switch-C.

```
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vc 1 60 passive
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 0 50 dest-address
47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00 1 60
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVC.

```
Switch-C# show atm vc interface atm 0/0/1 1 60
Interface:ATM0/0/1, Type:oc3suni
VPI = 1  VCI = 60
Status:UP
Time-since-last-status-change:00:01:15
Connection-type:SoftVC
Cast-type:point-to-point
Passive half leg
Soft vc location:Destination
Remote ATM address:47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00
Remote VPI:0
Remote VCI:50
Soft vc call state:Active
Packet-discard-option:disabled
Usage-Parameter-Control (UPC):pass
Wrr weight:2
Number of OAM-configured connections:0
OAM-configuration:disabled
OAM-states: Not-applicable
Cross-connect-interface:ATM4/0/3, Type:oc3suni
Cross-connect-VPI = 0
Cross-connect-VCI = 50
Cross-connect-UPC:pass
Cross-connect OAM-configuration:disabled
Cross-connect OAM-state: Not-applicable
Threshold Group:5, Cells queued:0
Rx cells:0, Tx cells:0
Tx Clp0:0,  Tx Clp1:0
Rx Clp0:0,  Rx Clp1:0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index:1
Rx service-category:UBR (Unspecified Bit Rate)
Rx pcr-clp01:7113539
Rx scr-clp01:none
Rx mcr-clp01:none
Rx      cdvt:1024 (from default for interface)
Rx       mbs:none
Tx connection-traffic-table-index:1
Tx service-category:UBR (Unspecified Bit Rate)
Tx pcr-clp01:7113539
Tx scr-clp01:none
Tx mcr-clp01:none
Tx      cdvt:none
Tx       mbs:none
```

The following example shows the configuration of the two-ended soft PVP with a passive half leg starting with the configuration of Switch-C.

```
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vp 1 passive
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config-if)# atm soft-vp 10 dest-address
47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00 1
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVP.

```
Switch-C# show atm vp interface atm 0/0/1 1
Interface: ATM0/0/1, Type: oc3suni
VPI = 1
Status: UP
Time-since-last-status-change: 00:00:07
Connection-type: SoftVP
Cast-type: point-to-point
Passive half leg
 Soft vp location: Destination
 Remote ATM address: 47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00
 Remote VPI: 10
 Soft vp call state: Active
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Configuring Access Filters on Soft PVC and Soft PVP Passive Connections

The access filters for soft PVC and soft PVP passive connections feature provides protection to the passive side of a soft PVC or soft PVP connection in two ways:

- prevents unauthorized access to an ATM network by external users.
- reserves the required resources for expected connections to switch.

The access filters for soft PVC and soft PVP passive connections feature uses the **access-control** parameter, to restrict access to the passive destination side of the soft PVC or soft PVP based on the source interface NSAP address of the connection and time of day.

You configure a filter set using the **atm filter-set** command on the passive soft PVC or soft PVP side. Configuring a filter set gives you the added flexibility to allow multiple NSAP addresses to access the passive destination side of the soft PVC or soft PVP and limit the time of day when to allow access. The examples later in this section show access control configured using both source ATM address and filter set configurations.

Configuring Access Filters on Soft PVC Passive Connections

To configure a access filters on a two-ended soft PVC passive connection, follow these steps:

.

	Command	Purpose
Step 1	Switch-C(config)# **atm filter-set** *name* [**index** [*number*]] [**permit** | **deny**] [*template* | **time-of-day** {**anytime** | *start-time* {*end-time*}}]	(Optional) Used to configure the **access-control filter-set** parameter in on the passive destination-side of the soft VC.
Step 2	Switch-C(config)# **interface atm** *card/subcard/port* Switch-C(config-if)#	Selects the interface, on the terminating switch, being configured.
Step 3	Switch-C(config-if)# **atm soft-vc** *dest-vpi dest-vci* **passive** [**pd** *pd*] [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**access-control** {**src-address** *atm-address* | **filter-set** *name*}]	Configures the passive leg on the terminating switch interface.
Step 4	Switch-B(config-if)# **atm soft-vc** *source-vpi source-vci* **dest-address** *atm-address dest-vpi dest-vci* [**enable** | **disable**] [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Creates a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.
Step 5	Switch-C(config-if)# **end**	Switches to EXEC command mode.
Step 6	Switch-C# **show atm vc interface atm** *card/subcard/port vpi vci*	Displays the passive half-leg configuration information of two-ended soft PVC.

Examples

Using a source address — The following example shows the configuration of the two-ended soft PVC (shown in Figure 7-8) with access control configured using a source address on the passive half leg. Start with the configuration of Switch-C.

```
Switch-C(config)# interface atm atm 0/0/1
Switch-C(config-if)# atm soft-vc 1 60 passive access-control src-address
47.0091.8100.0000.0010.073c.0101.4000.0c80.9030.00
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 0 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 1 60
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVC with the access control source ATM NSAP address.

```
Switch-C# show atm vc interface atm0/0/1 1 60

Interface: ATM11/0/0, Type: quad_oc12suni
VPI = 1  VCI = 60
Status: UP
Time-since-last-status-change: 1d08h
Connection-type: SoftVC
Cast-type: point-to-point
Passive half leg
 Soft vc location: Destination
 Remote ATM address: default
 Remote VPI: 0
 Remote VCI: 50
➔ Access Control:
➔    Source address: 47.0091.8100.0000.0010.073c.0101.4000.0c80.9030.00
 Soft vc call state: Active
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none

Switch-C#
```

Using a simple filter set — The following example shows the configuration of the two-ended soft PVC (shown in Figure 7-8) with access control configured using a simple filter-set on the passive half leg. Start with the configuration of Switch-C and configure the filter set to permit one ATM NSAP address to access the passive side of the soft PVC. Then associate the filter set when configuring the passive leg of the soft PVC.

```
Switch-C(config)# atm filter-set fset1 permit
47.0091.8100.0000.0010.073c.0101.4000.0c80.9030.00
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vc 1 60 passive access-control filter-set fset1
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 0 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 1 60
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVC with the filter set fset1 configured.

```
Switch-C# show atm vc interface atm 0/0/1 23 1 60

Interface: ATM11/0/0, Type: quad_oc12suni
VPI = 1  VCI = 60
Status: UP
Time-since-last-status-change: 1d08h
Connection-type: SoftVC
Cast-type: point-to-point
Passive half leg
 Soft vc location: Destination
 Remote ATM address: default
 Remote VPI: 0
 Remote VCI: 50
 Access-control: Filter-set - fset1
Soft vc call state: Active
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none

Switch-C#
```

Using a filter set with multiple NSAP addresses — The following example shows the configuration of the two-ended soft PVC (shown in Figure 7-8) with access control configured using a more complex filter-set on the passive half leg. Start with the configuration of Switch-C and configure the filter set to permit two ATM NSAP addresses to access the passive side of the soft PVC. Then associate the filter set when configuring the passive leg of the soft PVC.

```
Switch-C(config)# atm filter-set fset5 index 1 permit 47.0091.8100.0000.0010.073c...
Switch-C(config)# atm filter-set fset5 index 2 permit 47.0091.8100.0000.0001.4204.d801...
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vc 1 60 passive access-control filter-set fset5
Switch-C(config-if)# end
Switch-C# show atm filter-set fset5
ATM filter set fset5
  permit 47.0091.8100.0000.0010.073c...  index 1
  permit 47.0091.8100.0000.0001.4204.d801...  index 2
Switch-C#
```

On Switch-B, create a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 0 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 1 60
```

Using a filter set with time-of-day filters — The following example shows the configuration of the two-ended soft PVC (shown in Figure 7-8) with access control configured using a filter-set with a time-of-day filter configured on the passive half leg. Start with the configuration of Switch-C and configure the filter set to permit an ATM NSAP address to access the passive side of the soft PVC but only for the hour between 10:00 and 11:00. Then associate the filter set when configuring the passive leg of the soft PVC.

```
Switch-C(config)# atm filter-set fset6 permit 47.0091.8100.0000.0010.073c...
Switch-C(config)# atm filter-set fset6 time-of-day 10:00 11:00
Switch-C(config-if)# atm soft-vc 1 60 passive access-control filter-set fset6
Switch-C(config-if)# end
Switch-C(config)# end
Switch-C# show atm filter-set fset6
ATM filter set fset6
  permit 47.0091.8100.0000.0010.073c...  index 1
  permit From 10:0 Hrs Till 11:0 Hrs  index 2
Switch-C#
```

On Switch-B, create a two-ended soft PVC on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 0 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 1 60
```

Configuring Access Filters on Soft PVP Passive Connections

To configure a access filters on a two-ended soft PVP passive connection, follow these steps:

	Command	Purpose
Step 1	Switch-C(config)# **atm filter-set** *name* [**index** [*number*]] [**permit** | **deny**] [*template* | **time-of-day** {**anytime** | *start-time* {*end-time*}}]	(Optional) Used to configure the **access-control filter-set** parameter on the passive destination-side of the soft VP.
Step 2	Switch-C(config)# **interface atm** *card/subcard/port* Switch-C(config-if)#	Selects the interface, on the terminating switch, being configured.
Step 3	Switch-C(config-if)# **atm soft-vp** *dest-vpi* **passive** [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**access-control** {**src-address** *atm-address* | **filter-set** *name*}]	Configures the passive leg on the terminating switch interface.
Step 4	Switch-B(config-if)# **atm soft-vp** *source-vpi* **dest-address** *atm-address dest-vpi* [**enable** | **disable**] [**upc** *upc*] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Creates a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.
Step 5	Switch-C(config-if)# **end**	Switches to EXEC command mode.
Step 6	Switch-C# **show atm vp interface atm** *card/subcard/port vpi*	Displays the passive half-leg configuration information of two-ended soft PVP.

Examples

Using a source address —The following example shows the configuration of the two-ended soft PVP (shown in Figure 7-8) with access control configured using a source address on the passive half leg. Start with the configuration of Switch-C.

```
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vp 60 passive access-control src-address
47.0091.8100.0000.0001.4204.d801.4000.0c80.9000.00
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vp 50 dest-address
47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00 60
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVP with the access control source ATM NSAP address configured.

```
Switch-C# show atm vp interface atm 0/0/1 60

Interface: ATM0/0/1, Type: quad_oc12suni
VPI = 60
Status: UP
Time-since-last-status-change: 1d08h
Connection-type: SoftVP
Cast-type: point-to-point
Passive half leg
 Soft vp location: Destination
 Remote ATM address: default
 Remote VPI: 0
 Access Control:
     Source address: 47.0091.8100.0000.0010.073c.0101.4000.0c80.8000.00
 Soft vp call state: Active
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none

Switch-C#
```

Using a filter set with multiple NSAP addresses — The following example shows the configuration of the two-ended soft PVP (shown in Figure 7-8) with access control configured using a simple filter-set on the passive half leg. Start with the configuration of Switch-C.

```
Switch-C(config)# atm filter-set fset1 permit
47.0091.8100.0000.0003.bbe4.aa01.4000.0c80.0000.64
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vp 60 passive access-control filter-set fset1
Switch-C(config-if)# end
Switch-C#
```

On Switch-B, create a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vp 50 dest-address
47.0091.8100.0000.0050.e209.8001.4000.0c82.0030.00 60
```

On Switch-C, display the passive half-leg configuration information of two-ended soft PVP with the filter set fset1 configured.

```
Switch-C# show atm vp interface atm 0/0/1 60

Interface: ATM0/0/1, Type: quad_oc12suni
VPI = 60
Status: UP
Time-since-last-status-change: 1d08h
Connection-type: SoftVP
Cast-type: point-to-point
Passive half leg
 Soft vp location: Destination
 Remote ATM address: default
 Remote VPI: 50
➔ Access filter: Filter-set - fset1
 Soft vp call state: Active
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none

Switch-C#
```

Using a filter set with multiple NSAP addresses — The following example shows the configuration of the two-ended soft PVP (shown in Figure 7-8) with access control configured using a more complex filter-set on the passive half leg. Start with the configuration of Switch-C and configure the filter set to permit two ATM NSAP addresses to access the passive side of the soft PVP. Then associate the filter set when configuring the passive leg of the soft PVP.

```
Switch-C(config)# atm filter-set fset5 index 1 permit 47.0091.8100.0000.0010.073c...
Switch-C(config)# atm filter-set fset5 index 2 permit 47.0091.8100.0000.0001.4204.d801...
Switch-C(config)# interface atm 0/0/1
Switch-C(config-if)# atm soft-vc 60 passive access-control filter-set fset5
Switch-C(config-if)# end
Switch-C# show atm filter-set fset5
ATM filter set fset5
  permit 47.0091.8100.0000.0010.073c...  index 1
  permit 47.0091.8100.0000.0001.4204.d801...  index 2
Switch-C#
```

On Switch-B, create a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 60
```

Using a filter set with time-of-day filters — The following example shows the configuration of the two-ended soft PVP (shown in Figure 7-8) with access control configured using a filter-set with a time-of-day filter configured on the passive half leg. Start with the configuration of Switch-C and configure the filter set to permit an ATM NSAP address to access the passive side of the soft PVP but only for the hour between 10:00 and 11:00. Then associate the filter set when configuring the passive leg of the soft PVP.

```
Switch-C(config)# atm filter-set fset6 permit 47.0091.8100.0000.0010.073c...
Switch-C(config)# atm filter-set fset6 time-of-day 10:00 11:00
Switch-C(config-if)# atm soft-vc 60 passive access-control filter-set fset6
Switch-C(config-if)# end
Switch-C(config)# end
Switch-C# show atm filter-set fset6
ATM filter set fset6
  permit 47.0091.8100.0000.0010.073c...  index 1
  permit From 10:0 Hrs Till 11:0 Hrs  index 2
Switch-C#
```

On Switch-B, create a two-ended soft PVP on the source switch that uses the passive half leg on the terminating switch.

```
Switch-B(config)# interface atm 3/0/1
Switch-B(config-if)# atm soft-vc 50 dest-address
47.0091.8100.0000.0001.4204.d801.4000.0c85.8000.00 60
```

Configuring Timer Rules Based Soft PVC and Soft PVP Connections

The timer rules based soft PVC and soft PVP feature allows you to configure a timer rule to set up or tear down a soft PVC or soft PVP based on the timer values configured. This means that the soft PVC or soft PVP can be established or deleted based on the time of the day, day of the week, or a specific date. These connections can also be programmed to become active for specified duration of time and then become inactive. The service can be extended beyond simple connection setup and deletion, based on the timer, to changing the connection parameters for the specified duration.

For example, this feature allows broadcasting service providers to specify soft PVC or soft PVP connections setup time for a specified duration to enable the video traffic to pass through. Once the timer expires, the connection is automatically torn down without any manual user intervention. This facility can also be used to provide a connection to the user, by the provider, with certain traffic parameters for a specified duration of time during the day and revert back to the default connection parameters for the rest of the day.

Note There will be a delay of 30 seconds in timer rules based soft-vc setup. This takes care of the soft-vc setup and release conflict, when multiple timer rules are configured as part of same timer group.

The maximum limits for the timed soft PVC and PVP features follow:

- Maximum timer groups supported: 64
- Maximum timer rules supported: 64
- Maximum timer rules within a timer group: 16
- Maximum timer groups using a timer rule: 16 (the same timer rule can be part of a maximum of 16 different timer groups)
- Maximum connections per timer group: 1024 (the same timer group can be applied to 1024 SPVC connections)

Configuring Timer Rules Based Soft PVCs

To configure the timer rule based soft PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm timer rule** *name* {**absolute start** *hh:mm date-month-year* {**duration** *hh:mm* | **end** *hh:mm date-month-year* } | **periodic** {**daily** | **weekday** | **weekend** | *day-of-the-week* } *hh:mm* {**duration** *hh:mm* | to *hh:mm day-of-the-week*} [**rx-cttr** *index*] [**tx-cttr** *index*]}	Creates a timer rule to specify the setup or teardown time for a soft PVC based on the timer values configured.
Step 2	Switch(config)# atm timer group *name* Switch(config-timer-grp)#	Creates and specifies the name of an ATM timer group and changes to ATM timer group configuration mode.
Step 3	Switch(config-timer-grp)# timer-rule *name*	Adds a previously configured timer rule to the ATM timer group.
Step 4	Switch(config-timer-grp)# exit	Exits ATM timer group configuration mode.
Step 5	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 6	Switch(config-if)# atm soft-vc *source-vpi source-vci* dest-address *atm-address dest-vpi dest-vci* [**timer-group** *name*]	Configures the soft PVC and allows you to configure a timer rules based setup and teardown timer for the soft PVC.

Example

The following example shows absolute timer configuration.

```
Switch# configure terminal

Switch(config)# atm timer rule rule1 absolute start 10:00 30 dec 2004 end 10:30 31 dec
2004
```

The following example creates a timer group and adds a timer rule to a timer group.

```
Switch(config)# atm timer group timerGrp1

Switch(config-timer-grp)# timer-rule rule1

Switch(config-timer-grp)# exit
```

The following example creates a time based soft-vc where a timer-group is associated to a soft-vc connection.

```
Switch(config)# interface atm 0/1/1

Switch(config-if)# atm soft-vc 10 120 dest-address

47.0091.8100.0000.00e0.f75d.0401.4000.0c80.0020.00 10 110 timer-group timerGrp1
```

Configuring Timer Rules Based Soft PVPs

To configure the timer rules based soft PVP, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm timer rule** *name* {**absolute start** *hh:mm date-month-year* {**duration** *hh:mm* | **end** *hh:mm date-month-year* } | **periodic** {**daily** | **weekday** | **weekend** | *day-of-the-week* } *hh:mm* {**duration** *hh:mm* | to *hh:mm day-of-the-week*} [**rx-cttr** *index*] [**tx-cttr** *index*]}	Creates a timer rule to specify the setup or teardown time for a soft PVC based on the timer values configured.
Step 2	Switch(config)# atm timer group *name* Switch(config-timer-grp)#	Creates and specifies the name of an ATM timer group and changes to ATM timer group configuration mode.
Step 3	Switch(config-timer-grp)# timer-rule *name*	Adds a previously configured timer rule to the ATM timer group.
Step 4	Switch(config-timer-grp)# exit	Exits ATM timer group configuration mode.
Step 5	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 6	Switch(config-if)# atm soft-vp *source-vpi* dest-address *atm-address dest-vpi* [timer-group *name*]	Configures the soft PVC and allows you to configure a timer rules based setup and teardown timer for the soft PVC.

Example

The following example configures a timer rules based soft PVP timer rule, creates an ATM timer group, and adds the timer group configuration to the soft PVP to set up or tear down the soft PVP based on the timer values configured.

```
Switch# configure terminal
Switch(config)# atm timer rule rule1 periodic friday 10:00 to friday 10:30 occurrence 4
Switch(config)# atm timer group timerGrp1
Switch(config-timer-grp)# timer-rule rule1
Switch(config-timer-grp)# exit
Switch(config)# interface atm 0/1/1
Switch(config-if)# atm soft-vp 120 dest-address
47.0091.8100.0000.00e0.f75d.0401.4000.0c80.0020.00 110 timer-group timerGrp1
```

Displaying the Timer Rules Based Soft PVC and Soft PVP Configuration

To display the timer rules based soft PVC and soft PVP configuration, use the following EXEC commands:

Command	Purpose
show atm timer rule [*rule-name***]**	Shows the timer rules based soft PVC and soft PVP feature timer rule configuration.
show atm timer group [*group-name*]	Displays the timer groups configured.
show atm soft-vc {p2p | p2mp} atm *card/subcard/port vpi vci* [**detail**]	Displays the configuration of an ATM soft PVC connection with the timer group and timer rule configured.
show atm vp [**interface atm** *card/subcard/port vpi*]	Shows the soft PVP configuration

Example

The following example is sample output from the **show atm timer rule** command.

```
Switch# show atm timer rule
atm timer rule rule1 periodic friday 10:00 to friday 10:30 rx-cttr 10 tx-cttr 10
atm timer rule rule2 absolute start 10:00 01 January 2004 duration 00:30 rx-cttr 100
tx-cttr 100
```

The following example is sample output from the **show atm timer group** command.

```
Switch# show atm timer group
timer-group: grp1

   timer-rule  rule1
   timer-rule  rule2

timer-group: grp2

   timer-rule  rule3
   timer-rule  rule4
   timer-rule  rule6

timer-group: grp3

   timer-rule  rule5
   timer-rule  rule6
```

The following example is sample output from the **show soft-vc** command.

```
Switch#show atm soft-vc p2p int a0/0/0 10 100 detail
        Interface: ATM0/0/0, Type: oc3suni
        VPI = 10  VCI = 100
        Connection-type: SoftVC
        Cast-type: point-to-point
        Soft vc location: Source
        Remote ATM address:
47.0091.8100.0000.0090.2159.a801.4000.0c80.0020.00
        Remote VPI: 10
        Remote VCI: 100
        Soft vc call state: Active
        Number of soft vc re-try attempts: 0
        First-retry-interval: 5000 milliseconds
        Maximum-retry-interval: 60000 milliseconds
        Aggregate admin weight: 0
        Timer-group: Group1
```

The following example displays the sample output from the **show atm-vp** for the timer rule based soft vp connection.

```
Switch#sh atm vp interface ATM2/0/1 100
Interface: ATM2/0/1, Type: oc3suni
VPI = 100
Status: UP
Time-since-last-status-change: 00:04:33
Connection-type: SoftVP
Cast-type: point-to-point
Hold-priority: none
Soft vp location: Source
Remote ATM address: 47.0091.8100.0000.00d0.ba53.5501.4000.0c81.1010.00
Remote VPI: 100
Soft vp call state: Active
Number of soft vp re-try attempts: 0
First-retry-interval: 5000 milliseconds
Maximum-retry-interval: 60000 milliseconds
Aggregate admin weight: 10080
TIME STAMPS:
Current Slot:2
Outgoing Setup May 23 17:58:40.713
Incoming Connect May 23 17:58:40.733
Timer Group: group11
<information deleted>
```

Configuring Backup Addresses for Soft PVC and Soft PVP Connections

This section describes configuring redundant destinations for soft PVCs and soft PVPs. Redundant soft PVC and soft PVP destinations allow you to configure the same NSAP address on two different ATM interfaces. The ATM interfaces can be on the same switch or different switches and use the same NSAP address in the source-end configuration for the soft PVC or soft PVP. If the active interface fails, the calls terminating on that interface for the redundant destination address are released and subsequently reestablished on the standby interface.

Additional redundant soft PVC and soft PVP configuration features include:

- Active and standby modes allow configuring the best destination as active and a standby destination if the active destination fails.
- Load balancing of the calls when both interfaces are up and working correctly and when active and standby interfaces are configured on the same switch.

Note Load balancing the redundant soft PVC and soft PVP destinations uses the number of calls received as the parameter to decide which interface to select.

How Redundant Soft VC Destinations Work

This section describes how the redundant soft VC destinations work in the following two possible configurations:

- Redundant Soft VC Destinations on the Same Switch, page 7-55
- Redundant Soft VC Destinations on Different Switches, page 7-57

Redundant Soft VC Destinations on the Same Switch

After using the **soft redundancy group** command to configure the NSAP address on an ATM interface the 19-byte prefix of the NSAP address is advertised over the PNNI. If the active and standby interfaces are configured on the same switch using the same 19-byte prefix of that NSAP address, one entry appears in the ATM routing tables for all nodes in PNNI network. For example, using the **show atm soft redundancy** command on Switch-A with redundant destinations configured shows the following:

- Group name: TEST
- NSAP address: 47.0091.8100.1111.1111.1111.2222.2222.2222.2222.00
- Redundant interfaces: ATM 2/0/2 (currently active) and ATM 2/0/3

```
   Switch-A# show atm soft redundancy group TEST
→  Group Name: TEST

→  Nsap Address: 47.0091.8100.1111.1111.1111.2222.2222.2222.2222.00
   Operating Mode: Active/Standby
→  Configured Active Interface: ATM2/0/2 (Status: Up, Currently Active)
→  Configured Standby Interface: ATM2/0/3 (Status: Up)
```

To check what NSAP address is advertised, use the **show atm route** command, as in the following example on Switch-C.

```
Switch-C# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary
Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 12   0           UP 0   47.0079.0000.0000.0000.0000.0000.00a0.3e00.0001/152
P  I 12   0           UP 0   47.0091.8100.0000.0060.3e5a.4500/104
P  I 10   0           UP 0   47.0091.8100.0000.0060.3e5a.4501/104
P  I 9    0           UP 0   47.0091.8100.0000.0090.2156.1401/104
P SI 1    0           UP 0   47.0091.8100.0000.0090.215d.b801/104
P  I 9    0           UP 0   47.0091.8100.1111.1111.1111.2222.2222.2222.2222/152
```

The NSAP address, 47.0091.8100.1111.1111.1111.2222.2222.2222.2222.00 is advertised as type internal. A PNNI internal prefix has higher precedence than an exterior prefix. Whenever the switch needs to route a soft PVC or soft PVP for a particular NSAP address (associated using the **soft redundancy group** command) and if there are two entries of the same prefix (one is internal and the other is exterior), the switch routes the call to the node that advertises the internal prefix.

Note To display the PNNI precedence configuration use the **show atm pnni precedence** command.

If the only entry in the ATM route table for the NSAP address 19-byte prefix appears as exterior the call is routed to the switch that advertised the exterior prefix.

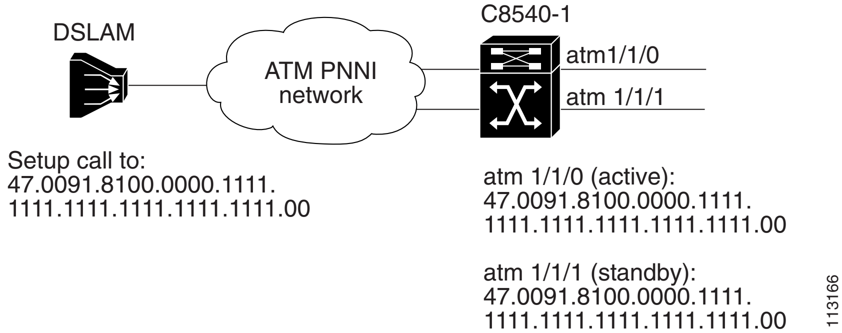
Following are details of how the prefixes of ATM NSAP addresses of the active and standby interfaces are advertised through PNNI (in this case the active and standby interfaces are on the same switch):

1. If both the active and standby interfaces are up, the switch advertises the 19-byte prefix of that NSAP address as an internal prefix.
2. If the active interface is up and the standby interface is down, the switch advertises the 19-byte prefix of that NSAP address as an internal prefix.
3. If the active interface is down and the standby interface is up, the switch advertises the 19-byte prefix of that NSAP address as an exterior prefix.
4. If both the active and standby interfaces are down, the switch does not advertise the 19-byte prefix of that NSAP address.

Figure 7-9 shows a DSLAM with a call setup to the ATM PNNI network and a single Catalyst 8540 MSR switch connected to the ATM PNNI network with redundant soft VC destinations on the C8540-1 switch:

- DSLAM has call setup to NSAP address—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant active ATM interface ATM 1/1/0 NSAP address on C8540-1—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant standby ATM interface ATM 1/1/1 NSAP address on C8540-1—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00

Figure 7-9 Redundant Soft PVC Destinations, Single Switch Example



Using this redundant configuration, if the active interface, ATM 1/1/0, fails for any reason or is shutdown, the calls are released and subsequently setup on the standby interface, ATM 1/1/1.

Redundant Soft VC Destinations on Different Switches

After using the **soft redundancy group** command to configure the NSAP address on an ATM interface the 19-byte prefix of the NSAP address is advertised over the PNNI. If the active and standby interfaces are configured on different switches using the same 19-byte prefix of that NSAP address, two entries appear in the ATM routing table at all nodes in PNNI network.

For example, using the **show atm soft redundancy** command on Switch-A with redundant destinations configured shows the following:

- Group name: TEST-2
- NSAP address: 47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant standby interface: ATM 2/0/3

```
Switch-A# show atm soft redundancy group
Group Name: TEST-2

Nsap Address: 47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
Operating Mode: Active/Standby
Configured Active Interface:
Configured Standby Interface: ATM2/0/3 (Status: Up)
```

For example, using the **show atm soft redundancy** command on Switch-B with redundant destinations configured shows the following:

- Group name: TEST-2
- NSAP address: 47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant active interface: ATM 2/0/3

```
Switch-B# show atm soft redundancy group
Group Name: TEST-2

➔ Nsap Address: 47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
Operating Mode: Active/Standby
➔ Configured Active Interface: ATM2/0/3 (Status: Up)
Configured Standby Interface:
```

To check what NSAP addresses are advertised, use the **show atm route** command, as in the following example on Switch-C.

```
Switch-C# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary
Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 12   0           UP 0   47.0079.0000.0000.0000.0000.0000.00a0.3e00.0001/152
P  I 12   0           UP 0   47.0091.8100.0000.0060.3e5a.4500/104
P SI 1    0           UP 0   47.0091.8100.0000.0060.3e5a.4501/104
P  I 9    0           UP 0   47.0091.8100.1111.1111.1111.1111.1111.1111.1111/152
P  E 10   0           UP 0   47.0091.8100.1111.1111.1111.1111.1111.1111.1111/152
P  I 10   0           UP 0   47.0091.8100.1111.1111.1111.2222.2222.2222.2222/152
```

If the active and standby interfaces are on different switches and configured with the same NSAP address, two entries appear in the ATM routing tables of all the nodes in the PNNI network. One entry with the 19-byte prefix is internal and another prefix entry is exterior, as show in the previous **show atm route** command example. A PNNI internal prefix has higher precedence than an exterior prefix. Whenever the switch needs to route a soft PVC or soft PVP for a particular NSAP address (associated using the **soft redundancy group** command) and if there are two entries of same prefix (one is internal and the other is exterior), the switch routes the call to the node that advertises the internal prefix.

Note To display the PNNI precedence configuration use the **show atm pnni precedence** command.

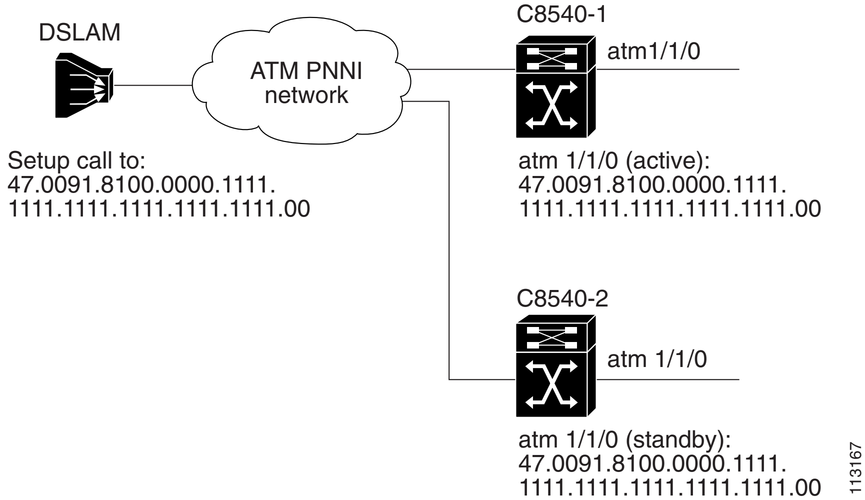
Following are the details of how the prefixes of ATM NSAP addresses of the active and standby interfaces are advertised through PNNI (in this case the active and standby interfaces are on different switches):

1. The switch, having the interface configured as active, advertises the 19-byte prefix of that NSAP address as an internal prefix.
2. The switch, having the interface configured as standby, advertises the 19-byte prefix of that NSAP address as an exterior prefix.

Figure 7-10 shows a DSLAM with a call setup to the ATM PNNI network and two Catalyst 8540 MSR switches connected to the ATM PNNI network with redundant soft VC destinations on the C8540-1 and C8540-2 switches:

- DSLAM has call setup to NSAP address—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant active ATM interface ATM 1/1/0 NSAP address on C8540-1—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00
- Redundant standby ATM interface ATM 1/1/0 NSAP address on C8540-2—
  47.0091.8100.1111.1111.1111.1111.1111.1111.1111.00

Figure 7-10 Redundant Soft PVC Destinations, Two Switch Example



Using this redundant configuration, if the active interface on switch C8540-1, ATM 1/1/0, fails for any reason or is shutdown, the calls are released and subsequently setup on the standby interface on switch C8540-2, ATM 1/1/0. Also, if a failure occurs anywhere along the path of the soft VC that causes the active destination to become unreachable from the source, the calls are automatically re-routed to the standby destination interface.

Configuring Redundant Soft VC Destinations

To configure a redundant soft VC destination, follow these steps:

	Command	Purpose
Step 1	Switch(config)# **atm soft redundancy group** *group-name* Switch(atmsoft-red)#	Configures a soft VC redundancy group and changes to ATM soft VC redundant configuration mode.
Step 2	Switch(atmsoft-red)# **nsap-address** *nsap-address*	Configures the NSAP-format ATM end-system address of an ATM interface.
Step 3	Switch(atmsoft-red)# [**no**] **load-balance**	Configures load balancing on a soft VC redundancy group.
Step 4	Switch(atm-soft-red)# **exit** Switch(config)#	Switches back to Global command mode.
Step 5	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface, on the terminating switch, being configured.
Step 6	Switch(config-if)# **atm soft redundancy member** *group-name* {**active** | **standby**}	Creates the redundant soft VC destination.
Step 7	Switch(config-if)# **end**	Switches to EXEC command mode.

	Command	Purpose
Step 8	Switch# **show atm soft redundancy group** [*group-name*]	Displays the ATM soft redundancy group configuration.
Step 9	Switch# **show atm addresses**	Displays the ATM NSAP address of the redundant soft PVC destination.

Examples

The following example shows the configuration of the redundant standby soft PVC destination (shown in Figure 7-9) on the switch C8540-1.

```
C8540-1# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
C8540-1(config)# atm soft redundancy group backup_vc
C8540-1(atmsoft-red)# nsap-address 47.0091.8100.0000.1111.1111.1111.1111.1111.1111.00
C8540-1(atmsoft-red)# exit
C8540-1(config)# interface atm 1/1/1
C8540-1(config-if)# atm soft redundancy member backup_vc standby
C8540-1(config-if)# end
C8540-1#
```

The following example shows the configuration of the active load balanced soft PVC destination (shown in Figure 7-9) on the switch C8540-1.

```
C8540-1# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
C8540-1(config)# atm soft redundancy group backup_vc
C8540-1(atmsoft-red)# load-balance
C8540-1(atmsoft-red)# nsap-address 47.0091.8100.0000.1111.1111.1111.1111.1111.1111.00
C8540-1(atmsoft-red)# exit
C8540-1(config)# interface atm 1/1/0
C8540-1(config-if)# atm soft redundancy member backup_vc active
C8540-1(config-if)# end
C8540-1#
```

The following example shows the configuration of the redundant standby soft PVC destination (shown in Figure 7-10) on the switch C8540-2.

```
C8540-2# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
C8540-2(config)# atm soft redundancy group backup_vc
C8540-2(atmsoft-red)# nsap-address 47.0091.8100.0000.1111.1111.1111.1111.1111.1111.00
C8540-2(atmsoft-red)# exit
C8540-2(config)# interface atm 1/1/0
C8540-2(config-if)# atm soft redundancy member backup_vc standby
C8540-2(config-if)# end
C8540-2#
```

Displaying the Redundant Soft VC Destination Address Configuration

To show the redundant soft VC destination address configuration, use the following EXEC command:

Command	Purpose
Switch# **show atm soft redundancy group** [*group-name*]	Displays the ATM soft redundancy group configuration.
Switch# **show atm addresses**	Displays the ATM NSAP address of the redundant soft PVC destination.

The following example shows all the ATM soft VC redundancy groups configured.

```
Switch# show atm soft redundancy group
Group Name: group1

Nsap Address: 47.0091.8100.0000.00a0.f209.b601.3000.0c88.1080.00
Operating Mode: Active/Standby
Configured Active Interface: ATM0/0/1 (Status: Down)
Configured Standby Interface:

Group Name: group2

Nsap Address: 47.0091.8100.0000.00a0.f209.b601.3333.3333.3333.00
Operating Mode: Active/Standby
Configured Active Interface: ATM0/0/1 (Status: Down)
Configured Standby Interface:

Group Name: group3

Nsap Address: 11.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
Operating Mode: Load Balance
    Interface Name Status  Number of VCs  Number of VPs
1:   ATM0/0/1       Up        1500         0
2:   ATM0/0/3       Up        1500         0

Group Name: group4

Nsap Address: 12.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
Operating Mode: Active/Standby
Configured Active Interface:
Configured Standby Interface:

Group Name: group5

Nsap Address: 13.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
Operating Mode: Load Balance
    Interface Name Status  Number of VCs  Number of VPs
1:   ATM0/1/ima0    Up        3            0
2:   ATM0/0/0       Up        3            0

Switch#
```

The following example shows the specific ATM soft VC redundancy group named group3.

```
Switch# show atm soft redundancy group group3
Group Name: group3

Nsap Address: 11.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
Operating Mode: Load Balance
    Interface Name Status  Number of VCs  Number of VPs
1:   ATM0/0/1       Up        1500           0
2:   ATM0/0/3       Up        1500           0

Switch#
```

The following **show atm addresses** command displays the *active* soft VC redundant address of Switch-A in a dual switch configuration.

```
Switch-A# show atm addresses
.
[Information Deleted]
.
Soft VC Redundant Address(es):
➔  47.0091.8100.0000.00a0.f209.b601.3000.0c88.1080.00 ATM0/0/1(A)
  47.0091.8100.0000.00a0.f209.b601.3333.3333.3333.00 ATM0/0/1(A)
  11.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00 ATM0/0/1 ATM0/0/3 - LB
  12.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
  13.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00 ATM0/1/ima0 ATM0/0/0 - LB

  A - Active Interface, S - Standby Interface, LB - Load Balance mode


Soft VC Address(es) for Frame Relay Interfaces :

[Information Deleted]
```

The following **show atm addresses** command displays the *standby* soft VC redundant address of Switch-B in a dual switch configuration.

```
Switch-B# show atm addresses
.
[Information Deleted]
.
Soft VC Redundant Address(es):
➔  47.0091.8100.0000.00a0.f209.b601.3000.0c88.1080.00 ATM0/0/1(S)
  11.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
  15.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00 ATM4/0/1(S)

  A - Active Interface, S - Standby Interface, LB - Load Balance mode


Soft VC Address(es) for Frame Relay Interfaces :

[Information Deleted]
```

The following **show atm addresses** command displays the both the *active* and *standby* soft VC redundant address of a single switch configuration with load balancing configured.

```
Switch# show atm addresses
.
[Information Deleted]
.
Soft VC Redundant Address(es):
  47.0091.8100.0000.00a0.f209.b601.3000.0c88.1080.00 ATM0/0/1(A)
  47.0091.8100.0000.00a0.f209.b601.3333.3333.3333.00 ATM0/0/1(A)
→ 11.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00 ATM0/0/1 ATM0/0/3 - LB
  12.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00
  13.2233.4455.6677.8c11.1111.1111.4000.0c80.0000.00 ATM0/1/ima0 ATM0/0/0 - LB

.
[Information Deleted]
.
```

Configuring Point-to-Multipoint Soft PVC Connections

This section describes configuring point-to-multipoint soft permanent virtual channel (PVC) connections which provide the following features:

- Connection to multiple hosts or ATM switch routers that support point-to-multipoint Soft PVC connections.
- Creation of point-to-multipoint PVC connections without the complexity of managing large configurations as described in Configuring Virtual Channel Connections.
- Provide reroute or retry capabilities when a failure occurs in the network

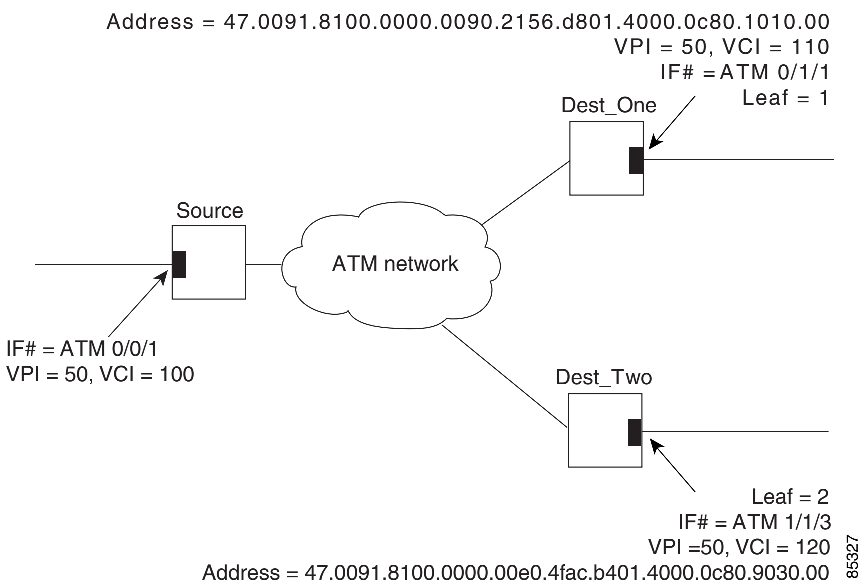
Note Point-to-Multipoint Soft-PVP connections are not supported.

Note Route Optimization is not supported for the Point-to-Multipoint Soft PVCs.

To configure point-to-multipoint circuit emulation services (CES) soft PVC connections see the "Configuring Point-to-Multipoint CES Soft PVC Connections" section on page 19-63.

Figure 7-11 illustrates the point-to-multipoint soft PVC connections used in the following examples.

Figure 7-11 Point-to-Multipoint Soft PVC Connection Example



Guidelines for Creating Point-to-Multipoint Soft PVCs

Perform the following steps when you configure point-to-multipoint soft PVCs:

Step 1 Determine which ports you want to define as participants in the point-to-multipoint soft PVC.

Step 2 Decide which of these ports you want to designate as the leaves of the soft PVC connection and which of these ports is the root. The leaves of the connection would be the Soft PVC destinations and the root would be the source.

Step 3 Retrieve the ATM addresses of the destination end of the soft PVC using the **show atm address** command.

Step 4 Retrieve the VPI/VCI values for the circuit using the **show atm vc** command.

Step 5 Configure the source (active) end of the soft PVC. At the same time, complete the point-to-multipoint soft PVC setup using the information derived from Step 3 and Step 4. Be sure to select an unused VPI/VCI value (one that does not appear in the **show atm vc** display).

Point-to-multipoint soft PVC connections have the following restrictions:

- Point-to-multipoint soft PVC connections can be sourced-from or terminated-on ATM and IMA interfaces only.
- Dynamic modification of the CTTR (connection traffic table row) on point-to-multipoint soft PVCs is not allowed.

Configuring Point-to-Multipoint Soft PVCs

To configure a point-to-multipoint soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show atm addresses**	Determines the destination ATM address.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters configuration mode from the terminal.
Step 3	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the interface to be configured.
Step 4	Switch(config-if)# **atm soft-vc** *source-vpi source-vci* **p2mp** Switch(atmsoft-p2mp)#	Changes to point-to-multipoint configuration mode and specifies the source-VPI and source-VCI.
Step 5	Switch(atmsoft-p2mp)# **party leaf-reference** *ref-number* Switch(atmsoft-p2mp-party)#	Configures the point-to-multipoint leaf reference number for each party and changes to point-to-multipoint-party configuration mode.
Step 6	Switch(atmsoft-p2mp-party)# **dest-address** *atm-address dest-vpi dest-vci*	Configures the destination ATM address and destination VPI and destination VCI for each party.

The following configuration example uses the interfaces and addresses displayed in Figure 7-11:

Examples

Step 1 Determine the ATM address of the Dest_One switch for ATM interface 0/1/1:

```
Dest_One# show atm addresses

Switch Address(es):
  47.0091.8100.0000.0090.2156.d801.0090.2156.d801.00 active
  47.0091.8100.0000.0040.0b0a.c501.0040.0b0a.c501.00
  NOTE: Switch addresses with selector bytes 01 through 7F
        are reserved for use by PNNI routing

PNNI Local Node Address(es):
  47.0091.8100.0000.0090.2156.d801.0090.2156.d801.01 Node 1

Soft VC Address(es):
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0000.00 ATM0/0/0
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0010.00 ATM0/0/1
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0020.00 ATM0/0/2
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0030.00 ATM0/0/3
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0040.00 ATM0/0/4
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0050.00 ATM0/0/5
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0060.00 ATM0/0/6
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0070.00 ATM0/0/7
  47.0091.8100.0000.0090.2156.d801.4000.0c88.0080.00 ATM0/0/ima0
➔ 47.0091.8100.0000.0090.2156.d801.4000.0c80.1000.00 ATM0/1/0
  47.0091.8100.0000.0090.2156.d801.4000.0c80.1010.00 ATM0/1/1
  47.0091.8100.0000.0090.2156.d801.4000.0c80.1020.00 ATM0/1/2


<Information deleted>
```

Step 2 At the source switch for the point-to-multipoint connection, change to interface configuration mode for ATM interface 0/0/1.

```
Source# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface atm 0/0/1
Source(config-if)#
```

Step 3 Use the **atm soft-vc** command to configure the source Soft PVC and switch to point-to-multipoint configuration mode.

```
Source(config-if)# atm soft-vc 50 100 p2mp
Source(atmsoft-p2mp)#
```

Step 4 Use the **party leaf-reference** command to configure reference 1 and change to point-to-multipoint party configuration mode.

```
Source(atmsoft-p2mp)# party leaf-reference 1
Source(atmsoft-p2mp-party)#
```

Step 5 Configure the destination ATM address obtained in Step 1 and the VPI and VCI of the destination connection.

```
Source(atmsoft-p2mp-party)# dest-address
47.0091.8100.0000.0090.2156.d801.4000.0c80.1010.00 50 110
Source(atmsoft-p2mp-party)# exit
```

Step 6 Use the following similar process to configure the Soft PVC connection to the Dest_Two switch:

```
Source(atmsoft-p2mp)# party leaf-reference 2
Source(atmsoft-p2mp-party)# dest-address
47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9030.00 50 120
Source(atmsoft-p2mp-party)# end
Source#
```

Step 7 Finally, confirm the connections are up and working using the commands in the section, "Displaying Point-to-Multipoint Soft PVC Configuration" section on page 7-67.

Displaying Point-to-Multipoint Soft PVC Configuration

To display the point-to-multipoint soft PVC configuration at either end of an ATM switch router, use the following EXEC commands:

Command	Purpose
show atm soft-vc p2mp interface atm *card/subcard/port vpi vci*	Shows point-to-multipoint soft PVC interface configuration.
show atm vc interface atm *card/subcard/port*	Shows the VCs configured on the ATM interface.

Examples

The following example shows the point-to-multipoint soft PVC configuration of Source, on interface ATM 0/0/2 out to the ATM network:

```
Source# show atm soft-vc p2mp interface atm 0/0/1 50 100
 Interface: ATM0/0/1, Type: oc3suni
VPI = 50  VCI = 100
Connection-type: SoftVC
Cast-type: point-to-multipoint-root
 Soft vc location: Source
 Soft vc call state: Inactive
Leaf-ref  VPI    VCI NSAP Address                                       State
    1      50    110 47.0091.8100.0000.0090.2156.d801.4000.0c80.1010.00 Inactive
    2      50    120 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9030.00 Inactive
Source#
```

The following example shows the point-to-multipoint soft PVC configuration of the Source switch, on interface ATM 0/0/1 (VPI = 50, VCI = 100):

```
Source# show atm vc interface atm 0/0/1 50 100

Interface: ATM0/0/1, Type: oc3suni
VPI = 50  VCI = 100
Status: NOT CONNECTED
Time-since-last-status-change: 04:45:52
Connection-type: SoftVC
Cast-type: point-to-multipoint-root
Hold-priority: none
 Soft vc location: Source
 Remote ATM address: default
 Remote VPI: 0
 Remote VCI: 0
 Soft vc call state: Inactive

Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Configuring Traffic Parameters for Point-to-Multipoint Soft-PVC Connections

To configure the traffic parameters for a point-to-multipoint Soft PVC connection, perform the following steps, beginning in ATM Soft PVC point-to-multipoint configuration mode:

	Command	Purpose
Step 1	Switch(atmsoft-p2mp)# **packet-discard** {**on** | **off** | **use-cttr**}	Configures the (early) packet discard option on a point-to-multipoint soft PVC connection.

	Command	Purpose
Step 2	Switch(atmsoft-p2mp)# **upc** {**drop** | **pass** | **tag**}	Configures the UPC options on a point-to-multipoint soft PVC connection.
Step 3	Switch(atmsoft-p2mp)# **cttr** {**rx** *index* | **tx** *index*}	Configures the connection traffic table row type and index on a point-to-multipoint soft PVC connection.

Note The row index for **cttr rx** and **cttr tx** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management." For non-UBR service categories a transmit connection traffic table row of same service category with 0 traffic parameter values must be specified.

Examples

The following example enables the early packet discard option on the point-to-multipoint soft PVC connection configured on an ATM interface:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm soft-vc 50 100 p2mp
Switch (atmsoft-p2mp)# packet-discard on
```

The following example configures the UPC (Usage-Parameter-Control) to drop all cells that do not conform to the configured traffic contract on the point-to-multipoint soft PVC connection:

```
Switch(atmsoft-p2mp)# upc drop
```

The following example configures CTTR (connection traffic table row) receive and transmit indexes on the point-to-multipoint soft PVC connection:

```
Switch(atmsoft-p2mp)# cttr rx 3 tx 64000
```

Enabling and Disabling the Root of a Point-to-Multipoint Soft-PVC Connections

To enable or disable the root of a point-to-multipoint Soft PVC connection, perform the following steps, beginning in ATM Soft PVC point-to-multipoint configuration mode:

	Command	Purpose
Step 1	Switch(atmsoft-p2mp)# **disable**	Disables the root of a point-to-multipoint Soft PVC connection and releases all parties.
Step 1	Switch(atmsoft-p2mp)# **enable**	Enables the root of a point-to-multipoint Soft PVC connection.

Note The **disable** option releases all the parties of the connection, and the Soft-PVC connection appears in the NOT_CONNECTED state. No retry will occur until you enable the Soft-PVC using the **enable** option.

Examples

The following example disables the root of a point-to-multipoint Soft PVC connection configured on an ATM interface and releases all parties:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm soft-vc 50 100 p2mp
Switch (atmsoft-p2mp)# disable
```

The following example reenables the root of a point-to-multipoint Soft PVC connection:

```
Switch (atmsoft-p2mp)# enable
```

Enabling and Disabling a Leaf of a Point-to-Multipoint Soft PVC

To enable or disable an individual leaf of a point-to-multipoint soft PVC connection, perform the following steps, beginning in soft PVC point-to-multipoint configuration mode:

	Command	Purpose
Step 1	Switch(atmsoft-p2mp)# **party leaf-reference** *ref-number* **disable** Switch(atmsoft-p2mp-party)#	Disables a leaf of a point-to-multipoint soft PVC connection.
Step 2	Switch(atmsoft-p2mp)# **party leaf-reference** *ref-number* **enable** Switch(atmsoft-p2mp-party)#	Enables a leaf of a point-to-multipoint soft PVC connection.

Examples

The following example disables an individual leaf of a point-to-multipoint soft PVC connection configured on an ATM interface:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface atm 1/0/2
Source(config-if)# atm soft-vc 10 100 p2mp
Source(atmsoft-p2mp)# party leaf-reference 20 disable
Source(atmsoft-p2mp-party)#
```

Note After disabling a party leaf the CLI changes from point-to-multipoint configuration mode to point-to-multipoint party configuration mode. This allows you to modify the party configuration and exit out of the party mode and enable the party leaf again with the modified configurations. For example, you can modify the retry interval, destination address, destination VPI and destination VCI.

The following example reenables an individual leaf of the point-to-multipoint soft PVC connection:

```
Switch(atmsoft-p2mp)# party leaf-reference 30 enable
Switch(atmsoft-p2mp)#
```

Confirming the Party Leaf is Disabled or Enabled

To confirm the individual leaf of the point-to-multipoint soft PVC is disabled or enabled, use the following EXEC command before and after disabling and enabling the point-to-multipoint soft PVCs:

Command	Purpose
show running-config interface atm *card/subcard/port*	Shows the configuration of the ATM interface.
show atm soft-vc p2mp interface atm *card/subcard/port vpi vci*	Shows point-to-multipoint soft PVC interface configuration.

Example

The following example shows how to confirm that the party leaf of the point-to-multipoint soft PVC is disabled from the interface using the **show running-config** command:

```
Source# show running-config interface atm 1/0/2
Building configuration...

Current configuration : 316 bytes
!
interface ATM1/0/2
 no ip address
 no atm ilmi-keepalive
 atm soft-vc 10 100 p2mp
  cttr rx 1 tx 1
➔  party leaf-reference 20 disable
  dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c81.8000.00 10 100
  party leaf-reference 30
  dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c81.8000.00 10 101
 !
end
```

Notice the word "disabled" appears following the party leaf-reference number for party leaf-reference 20 disabled in the previous section.

Note The word "enabled" does not appears following the party leaf-reference number for party leaf-reference 30 that was not disabled. Enabled is the default state.

The following example shows how to confirm that the party leaf of the point-to-multipoint soft PVCs is disabled from the interface using the **show atm soft-vc p2mp interface atm** command:

```
Source# show atm soft-vc p2mp interface atm 1/0/2 10 100
 Interface: ATM1/0/2, Type: oc3suni
VPI = 10  VCI = 100
Connection-type: SoftVC
Cast-type: point-to-multipoint-root
 Soft vc location: Source
 Soft vc call state: Active
Leaf-ref  VPI    VCI NSAP Address                                       State
➔      20   10     100 47.0091.8100.0000.0003.6bb4.c501.4000.0c81.8000.00 Inactive
➔      30   10     101 47.0091.8100.0000.0003.6bb4.c501.4000.0c81.8000.00 Active
```

The word "Inactive" appears under the State field for party leaf-reference 20 disable in the previous section but, the second party leaf-reference 30, that was not disabled, has the word "Active" under the State field.

Configuring the Retry Interval for Point-to-Multipoint Soft-PVC Parties

To configure the first and maximum retry intervals for each party of a point-to-multipoint Soft PVC connection, perform the following steps, beginning in ATM Soft PVC party configuration mode:

Command	Purpose
Switch(atmsoft-p2mp-party)# **retry-interval first** {**100-3600000**} **maximum** {**100-4294967295**}	Configures the first and maximum retry intervals in milliseconds on a point-to-multipoint soft PVC connection.

Examples

The following example configures the first and maximum retry intervals for each party of a point-to-multipoint soft PVC connection configured on an ATM interface:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm soft-vc 50 100 p2mp
Switch(atmsoft-p2mp)# party leaf-reference 2
Switch(atmsoft-p2mp-party)# retry-interval first 200 maximum 300
```

Deleting a Point-to-Multipoint Soft PVC

This section describes how to delete a point-to-multipoint soft PVC configured on an interface.

To remove the whole point-to-multipoint soft PVC connection, perform the following steps, beginning in global configuration mode:

Command	Purpose
Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Switch(config-if)# **no atm soft-vc** *vpi vci*	Deletes all of the point-to-multipoint soft PVCs.

Example

The following example shows how to remove the whole point-to-multipoint soft PVC connection configured on ATM interface 0/0/1, VPI = 50, VCI = 100:

```
Source# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface atm 0/0/1
Source(config-if)# no atm soft-vc 50 100
```

To delete an individual point-to-multipoint soft PVC leaf connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm soft-vc** *vpi vci* **p2mp** Switch(atmsoft-p2mp)#	Selects the soft PVC connection and changes configuration mode.
Step 3	Switch(atmsoft-p2mp)# **no party leaf-reference** *ref-number*	Deletes only one leaf reference.

Example

The following example shows how to delete only **party leaf-reference 2** of the point-to-multipoint soft PVCs configured on ATM interface 0/0/1, VPI = 50, VCI = 100:

```
Source(config)# interface atm 0/0/1
Source(config-if)# atm soft-vc 50 100 p2mp
Source(atmsoft-p2mp)# no party leaf-reference 2
```

Confirming VCC Deletion

To confirm the deletion of the point-to-multipoint soft PVCs from an interface, use the following EXEC command before and after deleting the point-to-multipoint soft PVCs:

Command	Purpose
show atm soft-vc p2mp interface atm *card/subcard/port* [*vpi vci*]	Shows the point-to-multipoint soft PVCs configured on the interface.

Example

The following example shows how to confirm that all the point-to-multipoint soft PVCs are deleted from the interface:

```
Source# show atm soft-vc p2mp interface atm 0/0/1 50 100
 Connection does not exist
Source#
```

The following example shows how to confirm that an individual leaf of the point-to-multipoint soft PVCs has been deleted from the interface:

```
Source# show atm soft-vc p2mp interface atm 0/0/1 50 100
 Interface: ATM0/0/1, Type: oc3suni
VPI = 50  VCI = 100
Connection-type: SoftVC
Cast-type: point-to-multipoint-root
 Soft vc location: Source
 Soft vc call state: Inactive
Leaf-ref  VPI    VCI NSAP Address                                       State
    1      50    120 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.9030.00 Inactive

Source#
```

Configuring Nondefault Well-Known PVCs

Normally the default well-known VCs are automatically created with default virtual channel identifiers (VCIs). However, for the unusual instances where the ATM switch router interfaces with nonstandard equipment, you can configure nondefault well-known VCI values on a per-interface basis.

For overview information about the well-known PVCs, refer to the *Guide to ATM Technology*.

Table 7-2 lists the default well-known VCs and their default configuration.

Table 7-2 Well-Known Virtual Channels

Channel Type	Virtual Path Identifier	Virtual Channel Identifier
Signalling	0	5
ILMI	0	16
PNNI	0	18
Tag switching	0	32

Caution Do not change the well-known channels to use a VC where the remote end is sending AAL5 messages not intended for the well-known VC. For example, do not swap VC values between two types of well-known VCs.

When you configure well-known VCs on physical interfaces using the CBR service category, the VC scheduling on the external interface is the same as the CBR VC configuration. This means that the VCs are allocated the bandwidth specified and are limited to that same bandwidth (shaped).

Note The connection from an external interface to the route processor is never shaped.

Overview of Nondefault PVC Configuration

Following is an overview of the steps needed to configure nondefault well-known VCs:

Step 1 Enable manual well-known VC configuration.

Step 2 Delete any existing automatically created well-known VCs.

Step 3 Configure the individual encapsulation type as follows:

- Signalling (QSAAL)
- ILMI
- PNNI
- Tag switching

Step 4 Copy the running-configuration file to the startup-configuration file.

Configuring Nondefault PVCs

To configure the nondefault PVCs for signalling, ILMI, and PNNI, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm manual-well-known-vc** {**keep** | **delete**}	Enters manual-well-known-vc mode.
Step 3	Switch(config-if)#**atm pvc** *vpi vci* [**rx-cttr** *index*] [**tx-cttr** *index*] **interface atm** *card/subcard/port* **any-vci** [**encap** {**ilmi** | **pnni** | **qsaal**}] or Switch(config-if)# **tag-switching atm control-vc** *vpi vci*	Configures the nondefault PVC for encapsulation type.
Step 4	Switch(config-if)# **end** Switch#	Returns to privileged EXEC mode.
Step 5	Switch# **copy system:running-config nvram:startup-config**	Copies the running configuration file to the startup configuration file.

Note An error condition occurs if either the signalling or ILMI well-known VCs remain unconfigured when an interface is enabled.

When you configure well-known VCs on physical interfaces using the CBR service category, the VC scheduling on the external interface is the same as the CBR VC configuration. This means that the VCs are allocated the bandwidth specified and are limited to that same bandwidth (shaped).

Note The connection from an external interface to the route processor is never shaped.

Example

The following example shows the nondefault VC configuration steps:

Step 1 Use the **show atm vc interface atm** command to display the configuration of the existing default well-known VCs for ATM interface 0/0/0.

Step 2 Change to interface configuration mode for ATM interface 0/0/0.

Step 3 Enter manual well-known-vc mode and delete the existing default well-known VCs using the **atm manual-well-known-vc delete** command.

Step 4 Confirm deletion by entering **y.**

Step 5 Configure the nondefault VC for signalling from 5 (the default) to 35 using the **atm pvc** command.

Step 6 Configure the ILMI VC, then configure the PNNI VC if needed using the same procedure.

Step 7 Save the new running configuration to the startup configuration.

An example of this procedure follows:

```
Switch# show atm vc interface atm 0/0/0
Interface     VPI    VCI    Type     X-Interface  X-VPI X-VCI   Encap Status
ATM0/0/0      0      5       PVC      ATM0          0      49    QSAAL  UP
ATM0/0/0      0      16      PVC      ATM0          0      33    ILMI   UP
ATM0/0/0      0      18      PVC      ATM0          0      65    PNNI   UP
Switch#
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm manual-well-known-vc delete

Okay to delete well-known VCs for this interface? [no]: y
Switch(config-if)# atm pvc 1 35 interface atm0 any-vci encap qsaal
Switch(config-if)# end
Switch#
%SYS-5-CONFIG_I: Configured from console by console
Switch# show atm vc interface atm 0/0/0
Interface     VPI    VCI    Type     X-Interface  X-VPI X-VCI   Encap Status
ATM0/0/0      1     35      PVC      ATM0          0      150    QSAAL  UP
Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
```

Configuring a VPI/VCI Range for SVPs and SVCs

You can configure a virtual path identifier/virtual channel identifier (VPI/VCI) range for switched virtual channels and switched virtual paths (SVCs and SVPs). ILMI uses the specified range to negotiate the VPI/VCI range parameters with peers. This feature allows you to:

- Specify ranges for SVPs/SVCs.
- Avoid VPI/VCI conflicts when attempting to set up soft PVPs or soft PVCs.

You can still configure PVPs and PVCs in any supported range, including any VPI/VCI range you configured for SVPs/SVCs.

Note This feature is supported in ILMI 4.0.

Note To ensure that SVCs are preserved during a route processor switchover, you must configure the switch to synchronize dynamic information between the route processors. For more information, see Chapter 3, "Initially Configuring the ATM Switch Router."

The default maximum switched virtual path connection (SVPC) VPI is equal to 255. You can change the maximum SVPC VPI by entering the **atm svpc vpi max** *value* command. See Table 7-3 for the allowable ranges.

Table 7-3 Maximum SVPC VPI Range

VPI Bit Type	Maximum Value Range
8-bit VPI	0 to 255
12-bit VPI[1]	0 to 4095

1. Only available on ATM NNI interfaces.

Note The maximum value specified applies to all interfaces except logical interfaces, which have a fixed value of 0.

For further information and examples of using VPI/VCI ranges for SVPs/SVCs, refer to the *Guide to ATM Technology*.

Every interface negotiates the local values for the maximum SVPC VPI, maximum SVCC VPI, and minimum SVCC VCI with the peer's local value during ILMI initialization. The negotiated values determine the ranges for SVPs and SVCs. If the peer interface does not support these objects or autoconfiguration is turned off on the local interface, the local values determine the range.

To configure a VPI/VCI range for SVCs/SVPs, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **atm svpc vpi max** *value*	Configures the maximum VPI value for a SVPC.
Step 3	Switch(config-if)# **atm svcc vpi max** *value*	Configures the maximum VPI value for a SVCC.
Step 4	Switch(config-if)# **atm svcc vci min** *value*	Configures the minimum VCI value for a SVCC.

The following example shows configuring ATM interface 0/0/0 with the SVPC and SVCC VPI maximum set to 100, and SVCC VCI minimum set to 60.

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm svpc vpi max 100
Switch(config-if)# atm svcc vpi max 100
Switch(config-if)# atm svcc vci min 60
Displaying the VPI/VCI Range Configuration
```

To confirm the VPI or VCI range configuration, use one of the following commands:

Command	Purpose
show atm interface atm *card/subcard/port*	Shows the ATM interface configuration.
show atm ilmi-status atm *card/subcard/port*	Shows the ILMI status on the ATM interface.

Examples

The following example shows how to confirm the VPI and VCI range configuration on an ATM interface. The values displayed for ConfMaxSvpcVpi, ConfMaxSvccVpi, and ConfMinSvccVci are local values. The values displayed for CurrMaxSvpcVpi, CurrMaxSvccVpi, and CurrMinSvccVci are negotiated values.

```
Switch# show atm interface atm 0/0/0
Interface:      ATM0/0/0        Port-type:      oc3suni
IF Status:      DOWN            Admin Status:   down
Auto-config:    enabled         AutoCfgState:   waiting for response from peer
IF-Side:        Network         IF-type:        UNI
Uni-type:       Private         Uni-version:    V3.0
ConfMaxVpiBits: 8               CurrMaxVpiBits: 8
ConfMaxVciBits: 14              CurrMaxVciBits: 14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 100             CurrMaxSvpcVpi: 100
ConfMaxSvccVpi: 100             CurrMaxSvccVpi: 100
ConfMinSvccVci: 60              CurrMinSvccVci: 60
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.0000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      3        0       0       0       0        0       0          3          0
Logical ports(VP-tunnels):     0
Input cells:    0               Output cells:   0
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 0, Output AAL5 pkts: 0, AAL5 crc errors: 0
```

The following example shows how to confirm the peer's local values for VPI and VCI range configuration by displaying the ILMI status on an ATM interface:

```
Switch# show atm ilmi-status atm 0/0/0

Interface : ATM0/0/0 Interface Type : Private NNI
ILMI VCC : (0, 16) ILMI Keepalive : Disabled
Addr Reg State:   UpAndNormal
Peer IP Addr:     172.20.40.232   Peer IF Name:     ATM0/0/0
Peer MaxVPIbits:  8               Peer MaxVCIbits:  14
Peer MaxVPCs:     255             Peer MaxVCCs:     16383
Peer MaxSvccVpi:  255             Peer MinSvccVci:  255
Peer MaxSvpcVpi:  48
Configured Prefix(s) :
47.0091.8100.0000.0010.11ba.9901
```

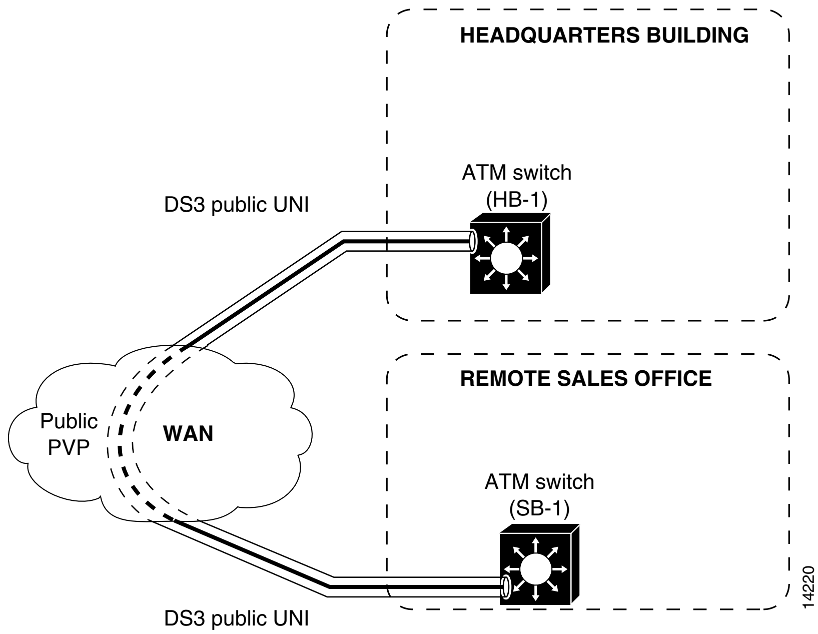
Note Note that the **show atm ilmi-status** command displays the information above only if the peer supports it.

Configuring VP Tunnels

This section describes configuring virtual path (VP) tunnels, which provide the ability to interconnect ATM switch routers across public networks using PVPs. You can configure a VP tunnel to carry a single service category, or you can configure a VP tunnel to carry multiple service categories, including merged VCs.

Figure 7-12 shows a public UNI interface over a DS3 connection between the ATM switch router (HB-1) in the Headquarters building and the ATM switch router (SB-1) in the Remote Sales building. To support signalling across this connection, a VP tunnel must be configured.

Figure 7-12 Public VP Tunnel Network Example



Configuring a VP Tunnel for a Single Service Category

The type of VP tunnel described in this section is configured as a VP of a single service category. Only virtual circuits (VCs) of that service category can transit the tunnel.

To configure a VP tunnel connection for a single service category, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] [{**vbr-rt** | **vbr-nrt**} **pcr** *pcr_value* {**scr0** | **scr10**} *scr_value* [**mbs** *mbs_value*] [**cdvt** *cdvt_value*] | [**cbr pcr** *pcr_value* [**cdvt** *cdvt_value*] | [**abr pcr** *pcr_value* [**mcr** *mcr_value*] [**cdvt** *cdvt_value*] | [**ubr pcr** *pcr_value* [**mcr** *mcr_value*] [**cdvt** *cdvt_value*]]	Configures the connection-traffic-table-row index for any nondefault traffic values (optional).
Step 2	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 3	Switch(config-if)# **atm pvp** *vpi* [**rx-cttr** *index*] [**tx-cttr** *index*]	Configures an interface permanent virtual path (PVP) leg.
Step 4	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 5	Switch(config)# **interface atm** *card/subcard/port.vpt#* Switch(config-subif)#	Creates a VP tunnel using a VP tunnel number that matches the PVP leg virtual path identifier (VPI).

Note The row index for nondefault **rx-cttr** and **tx-cttr** must be configured before these optional parameters are used.

Examples

The following example shows how to configure the ATM VP tunnel on the ATM switch router (HB-1) at interface ATM 1/0/0, VPI 99:

```
Switch(HB-1)(config)# interface atm 1/0/0
Switch(HB-1)(config-if)# atm pvp 99
Switch(HB-1)(config-if)# exit
Switch(HB-1)(config)# interface atm 1/0/0.99
Switch(HB-1)(config-subif)# end
Switch(HB-1)#
```

The following example shows how to configure the ATM VP tunnel on the ATM switch router (SB-1) interface ATM 0/0/0, VPI 99:

```
Switch(SB-1)(config)# interface atm 0/0/0
Switch(SB-1)(config-if)# atm pvp 99
Switch(SB-1)(config-if)# exit
Switch(SB-1)(config)# interface atm 0/0/0.99
Switch(SB-1)(config-subif)# end
Switch(SB-1)#
```

Displaying the VP Tunnel Configuration

To show the ATM virtual interface configuration, use the following EXEC command:

Command	Purpose
show atm interface atm *card***/***subcard***/***port***.***vpt#*	Shows the ATM interface configuration.

The following example shows the ATM virtual interface configuration for interface ATM 1/0/0.99:

```
Switch# show atm interface atm 1/0/0.99
Interface:      ATM1/0/0.99     Port-type:      vp tunnel
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   waiting for response from peer
IF-Side:        Network         IF-type:        UNI
Uni-type:       Private         Uni-version:    V3.0
<information deleted>
```

Configuring a Shaped VP Tunnel

This section describes configuring a shaped VP tunnel for a single service category with rate-limited tunnel output on a switch.

A shaped VP tunnel is configured as a VP of the CBR service category. By default, this tunnel can carry VCs only of the CBR service category. However, you can configure this VP tunnel to carry VCs of other service categories. The overall output of this VP tunnel is rate-limited by hardware to the peak cell rate (PCR) of the tunnel.

Note Shaped VP tunnels are supported only on systems with the FC-PFQ feature card. (Catalyst 8510 MSR and LightStream 1010)

A shaped VP tunnel is defined as a CBR VP with a PCR. The following limitations apply:

- A maximum of 64 shaped VP tunnels can be defined on each of the following interface groups: (0/0/*x*, 1/0/*x*), (0/1/*x*, 1/1/*x*), (2/0/*x*, 3/0/*x*), (2/1/*x*, 3/1/*x*), (9/0/*x*, 10/0/*x*), (9/1/*x*, 10/1/*x*), (11/0/*x*, 12/0/*x*), and (11/1/*x*, 12/1/*x*). (Catalyst 8540 MSR)
- A maximum of 64 shaped VP tunnels can be defined on interfaces *x*/0/*y*; similarly, a maximum of 64 shaped VP tunnels can be defined on interfaces *x*/1/*y*. (Catalyst 8510 MSR and LightStream 1010)
- The bandwidth of the shaped VP tunnel is shared by the active VCs inside the tunnel in strict round-robin (RR) fashion.

- Even though the shaped VP tunnel is defined as CBR, it can carry VCs of another service category by substituting the new service category after the tunnel interface has been initially configured. For configuration information, see Chapter 9, "Configuring Resource Management."
- Shaped VP tunnels do not support merged VCs for tag switching.
- UBR+ and ABR VCs with non-zero MCR are not allowed on a shaped VP tunnel interface.
- The maximum VCs that can transit a shaped VP tunnel interface are determined by the following chassis configuration:
  - Catalyst 8540 with redundant route processors, a maximum of 125 VCs
  - Catalyst 8540 with no redundant route processor, a maximum of 128 VCs
  - Catalyst 8510, a maximum of 128 VCs
- Shaped VP tunnels support interface overbooking. For configuration information, see the Chapter 9, "Configuring Resource Management."
- Shaped VP tunnels cannot be configured with ATM router modules because CBR scheduling is not supported on those interfaces.

Configuring a Shaped VP Tunnel on an Interface

To configure a shaped VP tunnel, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **cbr pcr** *rate*	Configures the connection-traffic-table row for the desired PVP CBR cell rate.
Step 2	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to configure.
Step 3	Switch(config-if)# **atm pvp** *vpi* **shaped rx-cttr** *index* **tx-cttr** *index*	Configures an interface PVP leg.
Step 4	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 5	Switch(config)# **interface atm** *card*/*subcard*/*port*.*vpt#* Switch(config-subif)#	Creates a shaped VP tunnel using a VP tunnel number that matches the PVP leg VPI.

Note The **rx-cttr** and **tx-cttr** row indexes must be configured before they are used.

Example

The following example shows how to configure a shaped VP tunnel with a VPI of 99 as ATM interface 0/0/0.99

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pvp 99 shaped rx-cttr 100 tx-cttr 100
Switch(config-if)# exit
Switch(config-if)# interface atm 0/0/0.99
Switch(config-subif)#
```

Displaying the Shaped VP Tunnel Configuration

To display the shaped VP tunnel interface configuration, use the following EXEC command:

Command	Purpose
show atm interface atm *card/subcard/port.vpt#*	Shows the ATM VP interface configuration.

For an example display from the **show atm interface** command, see Displaying the Hierarchical VP Tunnel Configuration, page 7-85.

Configuring a Hierarchical VP Tunnel for Multiple Service Categories

This section describes configuring a hierarchical VP tunnel for multiple service categories with rate-limited tunnel output.

A hierarchical VP tunnel allows VCs of multiple service categories to pass through the tunnel. In addition, the overall output of the VP tunnel is rate-limited to the PCR of the tunnel. There is no general limit on the number of connections allowed on a such a tunnel. Hierarchical VP tunnels can also support merged VCs for tag switching. See Chapter 16, "Configuring Tag Switching and MPLS."

Service categories supported include the following:

- Constant bit rate (CBR)
- Variable bit rate (VBR)
- Available bit rate (ABR) with a nonzero minimum cell rate (MCR)
- Unspecified bit rate (UBR+) with a nonzero MCR

Note Hierarchical VP tunnels are supported only on systems with the FC-PFQ feature card. (Catalyst 8510 MSR and LightStream 1010)

While capable of carrying any traffic category, a hierarchical VP tunnel is itself defined as CBR with a PCR. The following limitations apply on the Catalyst 8540 MSR:

- Hierarchical VP tunnels can be defined only on interfaces in slots 0, 2, 9, and 11.
- For carrier module port adapters, interfaces 0/*x*/*y*, 2/*x*/*y*, 9/*x*/*y*, and 11/*x*/*y* can each support 30 hierarchical VP tunnels, for a combined total of 120. For OC-12 full-width modules, ports 0/0/[0-1], 0/0/[2-3], 2/0/[0-1], 2/0/[2-3], 9/0/[0-1], 9/0/[2-3], 11/0/[0-1], and 11/0/[2-3] can each support 30 hierarchical VP tunnels, for a combined total of 240.

The following limitations apply on the Catalyst 8510 MSR and LightStream 1010:

- A maximum of 30 hierarchical VP tunnels can be defined on interfaces 0/0/x and 3/0/x. A maximum of 30 hierarchical VP tunnels can be defined on interfaces 0/1/x and 3/1/x.
- Hierarchical VP tunnels can be defined only on interfaces in slots 0 and 3.

The following limitations apply on the Catalyst 8540 MSR, Catalyst 8510 MSR and LightStream 1010:

- Only hierarchical VPs are allowed on the interface (not other VCs or VPs).
- Bandwidth allocated on output to a hierarchical VP cannot be used by another hierarchical VP.

- At system boot, when global hierarchical scheduling is enabled, the switch router initializes the slot pairs according to the following restrictions:
  - Hierarchical scheduling is disabled for any slot pair that contains an ATM router module or Ethernet interface module. On the Catalyst 8540 MSR, the slot pairs are slots 0 and 1, slots 2 and 3, slots 9 and 10, and slots 11 and 12. On the Catalyst 8510 MSR and LightStream 1010, the slot pairs are slots 0 and 1 and slots 3 and 4.
  - Hierarchical scheduling is enabled for any slot pair that has an ATM port adapter or interface module in one slot and the other slot empty, or ATM port adapters or interface modules in both slots.
  - If a slot pair is empty, the hierarchical scheduling mode is determined by the first port adapter or interface module that is installed in the slot pair. If you insert an ATM port adapter or interface module first, hierarchical scheduling is enabled; if you insert an ATM router module or Ethernet interface module first, hierarchical scheduling is disabled.
- If hierarchical scheduling is enabled for a slot pair, ATM router modules or Ethernet interface modules inserted into the slot pair do not function.
- If hierarchical scheduling is disabled for a slot pair, ATM port adapters or interface modules inserted into the slot pair do not support hierarchical VP tunnels, and any hierarchical VP tunnels configured for the slot pair do not function.
- Hierarchical VP tunnels support interface overbooking. For configuration information, see Chapter 9, "Configuring Resource Management."

Enabling Hierarchical Mode

Before configuring a hierarchical VP tunnel, you must first enable hierarchical mode, then reload the ATM switch router. Perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm hierarchical-tunnel**	Enables hierarchical mode.
Step 2	Switch(config)# **exit** Switch#	Exits global configuration mode.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Saves the running configuration to the startup configuration.
Step 4	Switch# **reload**	Reloads the operating system.

Note Enabling hierarchical mode causes the minimum rate allocated for guaranteed bandwidth to a connection to be increased.

Example

The following example shows how to enable hierarchical mode, then save and reload the configuration.

```
Switch(config)# atm hierarchical-tunnel
Switch(config)# exit
Switch# copy system:running-config nvram:startup-config
Switch# reload
Configuring a Hierarchical VP Tunnel on an Interface
```

To configure a hierarchical VP tunnel, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **cbr pcr** *rate*	Configures the connection-traffic-table row for the desired PVP CBR cell rate.
Step 2	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 3	Switch(config-if)# **atm pvp** *vpi* **hierarchical rx-cttr** *index* **tx-cttr** *index*	Configures an interface PVP leg.
Step 4	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 5	Switch(config)# **interface atm** *card/subcard/port***.***vpt#* Switch(config-subif)#	Creates a hierarchical VP tunnel using a VP tunnel number that matches the PVP leg VPI.

Note The **rx-cttr** and **tx-cttr** row indexes must be configured before they are used.

Example

The following example shows how to configure a hierarchical VP tunnel with a PVP of 99 as ATM interface 0/0/0.99

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pvp 99 hierarchical rx-cttr 100 tx-cttr 100
Switch(config-if)# exit
Switch(config-if)# interface atm 0/0/0.99
Switch(config-subif)#
```

Displaying the Hierarchical VP Tunnel Configuration

To display the hierarchical VP tunnel interface configuration, use the following EXEC command:

Command	Purpose
show atm interface atm *card/subcard/port***.***vpt#*	Shows the ATM VP interface configuration.

Example

The following example shows the VP tunnel configuration on interface ATM 1/0/0 with PVP 99:

```
Switch# show atm interface atm 1/0/0.99
Interface:      ATM1/0/0.99     Port-type:      vp tunnel
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   waiting for response from peer
IF-Side:        Network         IF-type:        UNI
Uni-type:       Private         Uni-version:    V3.0
Max-VPI-bits:   0               Max-VCI-bits:   14
Max-VP:         0               Max-VC:         16383
ConfMaxSvpcVpi: 0               CurrMaxSvpcVpi: 0
ConfMaxSvccVpi: 0               CurrMaxSvccVpi: 0
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0060.3e64.fe01.4000.0c81.9000.63
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs Total-Cfgd Inst-Conns
      4        0       0       0          4          4
```

Configuring an End-Point PVC to a PVP Tunnel

To configure an end point of a permanent virtual channel (PVC) to a previously created PVP tunnel, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **atm pvc** *vpi-a vci-a* [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] **interface atm** *card/subcard/port.vpt# vpi-b vci-b* [**upc** *upc*]	Configures the PVC with the VPI of the tunnel leg matching the tunnel VP tunnel number.

The following restrictions apply to an end point of a PVC-to-PVP tunnel subinterface:

- The VPI number of the tunnel leg of any PVC connection must match the VP tunnel number of the tunnel.
- For single service-category VP tunnels, the service class specified by the connection-traffic-table row (CTTR) of any PVC connections must match the service category for the row(s) selected for the tunnel PVP (for simple VP tunnels), or the configured service category (for shaped VP tunnels). This restriction does not apply to VP tunnels configured for multiple service categories (hierarchical VP tunnels).
- For service classes other than UBR, the PCRs of all PVCs must be within the peak cell rate of the tunnel PVP. This setup requires new CTTR rows to be defined for CBR or VBR PVCs, with peak cell rates that are less than the intended tunnel PVP.

Example

The following example shows how to configure the example tunnel ATM 1/0/0.99 with a PVC from ATM interface 0/0/1 to the tunnel at ATM interface 1/0/0.99:

```
Switch(HB-1)(config)# interface atm 0/0/1
Switch(HB-1)(config-if)# atm pvc 0 50 interface atm 1/0/0.99 99 40
```

Displaying PVCs

To confirm PVC interface configuration, use the following EXEC command:

Command	Purpose
show atm vc interface atm *card/subcard/port*	Shows the ATM VC interface configuration.

Example

The following example shows the configuration of ATM subinterface 1/0/0.99 on the ATM switch router Switch(HB-1):

```
Switch(HB-1)# show atm vc interface atm 0/0/1
Interface    VPI   VCI   Type    X-Interface  X-VPI X-VCI  Encap Status
ATM0/0/1     0     5      PVC     ATM2/0/0     0     41    QSAAL  UP
ATM0/0/1     0     16     PVC     ATM2/0/0     0     33    ILMI   UP
ATM0/0/1     0     50     PVC     ATM1/0/0.99  99    40           UP
```

Configuring Signalling VPCI for VP Tunnels

You can specify the value of the virtual path connection identifier (VPCI) that is to be carried in the signalling messages within a VP tunnel. The connection identifier information element (IE) is used in signalling messages to identify the corresponding user information flow. The connection identifier IE contains the VPCI and VCI.

Note By default, the VPCI is the same as the VPI on the ATM switch router.

This feature can also be used to support connections over a virtual UNI.

To configure a VP tunnel connection signalling VPCI, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port***.***vpt#* Switch(config-if)#	Selects the subinterface.
Step 2	Switch(config-if)# **atm signalling vpci** *vpci-number*	Configures the ATM signalling VPCI number 0 to 255.

Example

The following example configures a VP tunnel on ATM interface 0/0/0, PVP 99, and then configures the connection ID VCPI as 0.

```
Switch(config)# interface atm 1/0/0
Switch(config-if)# atm pvp 99
Switch(config-if)# exit
Switch(config)# interface atm 1/0/0.99
Switch(config-subif)# atm signalling vpci 0
Switch(config-subif)# end
```

Displaying the VP Tunnel VPCI Configuration

To confirm the VP tunnel VPCI configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Shows the VP tunnel subinterface configuration.

Deleting VP Tunnels

To delete a VP tunnel connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **no interface atm** *card***/***subcard***/***port***.***vpt#*	Deletes the subinterface.
Step 2	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the physical interface to be modified.
Step 3	Switch(config-if)# **no atm pvp** *vpi*	Deletes the interface PVP half-leg.

Example

The following example shows deleting subinterface 99 at ATM interface 1/0/0 and then PVP half-leg 99:

```
Switch(HB-1)(config)# no interface atm 1/0/0.99
Switch(HB-1)(config)# interface atm 1/0/0
Switch(HB-1)(config-if)# no atm pvp 99
```

Confirming VP Tunnel Deletion

To confirm the ATM virtual interface deletion, use the following EXEC command:

Command	Purpose
show atm interface [**atm** *card***/***subcard***/***port*[**.***vpt#*]]	Shows the ATM interface configuration.

Example

The following example shows that ATM subinterface 1/0/0.99 on the ATM switch router (HB-1) has been deleted:

```
Switch(HB-1)# show interfaces atm 1/0/0
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
ConfMaxVpiBits: 8               CurrMaxVpiBits: 8
ConfMaxVciBits: 14              CurrMaxVciBits: 14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.4fac.b401.4000.0c80.8000.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      4        0       0       0       0        0       0          4          3
Logical ports(VP-tunnels):     0
Input cells:    263843          Output cells:   273010
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 172265, Output AAL5 pkts: 176838, AAL5 crc errors: 0
```

Configuring Interface and Connection Snooping

Snooping allows the cells from all connections, in either receive or transmit direction, on a selected physical port to be transparently mirrored to a snoop test port where an external ATM analyzer can be attached. Unlike shared medium LANs, an ATM system requires a separate port to allow nonintrusive traffic monitoring on a line.

Note Only cells that belong to existing connections are sent to the snoop test port. Any received cells that do not belong to existing connections are not copied. In addition, the STS-3c (or other) overhead bytes transmitted at the test port are not copies of the overhead bytes at the monitored port.

Snooping Test Ports (Catalyst 8510 MSR and LightStream 1010)

With the FC-PCQ installed, only the highest port on the last module in the ATM switch router can be configured as a snoop test port. Table 7-4 lists the interface number of the allowed snoop test port for the various port adapter types. If you specify an incorrect snoop test port for the currently installed port adapter type, an error appears on the console. The feature card per-class queuing (FC-PCQ) also does not support per-connection snooping.

The port number of the test port depends on the card type. Table 7-4 lists the allowed snoop test port number for the supported interfaces.

Table 7-4 Allowed ATM Snoop Ports with FC-PCQ

Interface	Port Number
25-Mbps	4/1/11[1]
OC-3	4/1/3
OC-12	4/1/0
DS3/E3	Not supported
CES	Not supported

1. Both transmit and receive interfaces must be on 25-Mbps port adapters.

Effect of Snooping on Monitored Port

There is no effect on cell transmission, interface or VC status and statistics, front panel indicators, or any other parameters associated with a port being monitored during snooping. Any port, other than the highest port, that contains a port adapter type with a bandwidth less than or equal to the port adapter bandwidth for the test port can be monitored by snooping.

Shutting Down Test Port for Snoop Mode Configuration

The port being configured as a test port must be shut down before configuration. While the test port is shut down and after snoop mode has been configured, no cells are transmitted from the test port until it is reenabled using the **no shutdown** command. A test port can be put into snoop mode even if there are existing connections to it; however, those connections remain “Down” even after the test port is reenabled using the **no shutdown** command. This includes any terminating connections for ILMI, PNNI, or signalling channels on the test port.

If you use a **show atm interface** command while the test port is enabled in snoop mode, the screen shows the following:

- Interface state appears as “Snooping” instead of “up” or “down.”
- Other ATM layer information for the test port is still displayed.
- Any previously configured connections on the test port remain installed, but are listed as Connection Status = down.
- Data for transmitted cells and output rates indicates the snooping cells are being transmitted.
- Counts for receive cells should remain unchanged and the input rate should be 0.

Other Configuration Options for Snoop Test Port

Most inapplicable configurations on the test port interface are disregarded while in snoop mode. However, the following configuration options are not valid when specified for the snoop test port and may affect the proper operation of the snoop mode on the test port:

- Diagnostic and PIF loopbacks of the snoop test port. These types of loopbacks do not function in snooping mode since the PIF receive side signals are disabled.
- Other physical layer loopbacks (line, cell, or payload) function normally when in snooping mode since they loop toward the line and are unaffected by the lack of PIF receive input.
- Interface pacing (with the rate for the snoop test port lower than the rate for the monitored port).
- Network-derived clock source using the snoop test port.
- Clock-source = loop-timed for the snoop test port.

Caution You should ensure that all options are valid and configured correctly while in the snoop mode.

Configuring Interface Snooping

The **atm snoop interface atm** command enables a snoop test port. Cells transmitted from the snoop test port are copies of cells from a single direction of a monitored port.

When in snoop mode, any prior permanent virtual connections to the snoop test port remain in the down state.

To configure interface port snooping, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm snoop interface atm** *card*/*subcard*/*port* **direction** [**receive** | **transmit**]	Specifies the interface and direction to be snooped.

Example

The following example shows how to configure ATM interface 12/1/3 as the port in snoop mode to monitor ATM interface 3/0/0, tested in the receive direction:

```
Switch(config)# interface atm 12/1/3
Switch(config-if)# atm snoop interface atm 3/0/0 direction receive
```

Displaying Interface Snooping

To display the test port information, use the following EXEC command:

Command	Purpose
show atm snoop	Displays the snoop configuration.

Example

The following example shows the snoop configuration on the OC-3c port and the actual register values for the highest interface:

```
Switch# show atm snoop
Snoop Test Port Name:  ATM12/1/3 (interface status=SNOOPING)
Snoop option:          (configured=enabled) (actual=enabled)
Monitored Port Name:   (configured=ATM3/0/0) (actual=ATM3/0/0)
Snoop direction:       (configured=receive) (actual=receive)
```

Configuring Per-Connection Snooping

With per-connection snooping you must specify both the snooped connection endpoint and the snooping connection endpoint. The Cisco IOS software adds the snooping connection endpoint as a leaf to the snooped connection. The root of the temporary multicast connection depends on the direction being snooped. Snooping in the direction of leaf to root is not allowed for multicast connections. Per-connection snooping features are as follows:

- Per-VC snooping
- Per-VP snooping

The snooping connection can be configured on any port when there is no VPI/VCI collision for the snoop connection with the existing connections on the port. Also the port should have enough resources to satisfy the snoop connection resource requirements. In case of failure, due to VPI/VCI collision or resource exhaustion, a warning message is displayed, and you can reconfigure the connection on a different port.

To snoop both transmit and receive directions of a connection, you need to configure two different snoop connections.

Note Per-connection snooping is available only with the switch processor feature card.

Nondisruptive per-connection snooping is achieved by dynamically adding a leaf to an existing connection (either unicast or multicast). This can lead to cell discard if the added leaf cannot process the snooped cells fast enough. For a multicast connection, the queue buildup is dictated by the slowest leaf in the connection. The leaf added for snooping inherits the same traffic characteristics as the other connection leg. This ensures that the added leaf does not become the bottleneck and affect the existing connection.

To configure connection snooping, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm snoop-vc** [*a-vpi a-vci*] **interface atm** *card*/*subcard*/*port x-vpi x-vci* [**direction** {**receive** | **transmit**}]	Configures the virtual channel to be snooped. *a* denotes the snooping connection. *x* denotes the snooped connection.
Step 3	Switch(config-if)# **atm snoop-vp** [*a-vpi*] **interface atm** *card*/*subcard*/*port x-vpi* [**direction** {**receive** | **transmit**}]	Configures the virtual path to be snooped.

Examples

The following example shows how to configure VC 100 200 on ATM interface 3/1/0 to snoop VC 200 150 on ATM interface 1/0/0:

```
Switch(config)# interface atm 3/1/0
Switch(config-if)# atm snoop-vc 100 200 interface atm 1/0/0 200 150 direction receive
```

The following example shows how to configure VP 100 on ATM interface 3/1/0 to snoop VP 200 on ATM interface 1/0/0:

```
Switch(config)# interface atm 3/1/0
Switch(config-if)# atm snoop-vp 100 interface atm 1/0/0 200 direction receive
```

Displaying Per-Connection Snooping

To display the test per-connection information, use the following EXEC commands:

Command	Purpose
show atm snoop-vc [**interface atm** *card***/***subcard***/***port* [*vpi vci*]]	Displays the snoop VC information.
show atm snoop-vp [**interface atm** *card***/***subcard***/***port* [*vpi*]]	Displays the snoop VP information.

Examples

The following example shows all VC snoop connections on the ATM switch router:

```
Switch> show atm snoop-vc
      Snooping                                    Snooped
Interface     VPI    VCI    Type     X-Interface  X-VPI  X-VCI  Dir     Status
ATM0/0/2      0      5      PVC      ATM0/1/1     0      5      Rx      DOWN
ATM0/0/2      0      16     PVC      ATM0/1/1     0      16     Rx      DOWN
ATM0/1/2      0      5      PVC      ATM0/0/1     0      5      Tx      DOWN
ATM0/1/2      0      16     PVC      ATM0/0/1     0      16     Tx      DOWN
ATM0/1/2      0      18     PVC      ATM0/0/1     0      18     Tx      UP
ATM0/1/2      0      100    PVC      ATM0/0/1     0      100    Tx      DOWN
ATM0/1/2      0      201    PVC      ATM0/0/1     0      201    Tx      DOWN
ATM0/1/2      0      202    PVC      ATM0/0/1     0      202    Tx      DOWN
ATM0/1/2      0      300    PVC      ATM0/0/1     0      300    Tx      DOWN
ATM0/1/2      0      301    PVC      ATM0/0/1     0      301    Tx      DOWN
```

The following example shows the VC snoop connections on ATM interface 0/1/2:

```
Switch> show atm snoop-vc interface atm 0/1/2
      Snooping                                    Snooped
Interface     VPI    VCI    Type     X-Interface  X-VPI  X-VCI  Dir     Status
ATM0/1/2      0      5      PVC      ATM0/0/1     0      5      Tx      DOWN
ATM0/1/2      0      16     PVC      ATM0/0/1     0      16     Tx      DOWN
ATM0/1/2      0      18     PVC      ATM0/0/1     0      18     Tx      UP
ATM0/1/2      0      100    PVC      ATM0/0/1     0      100    Tx      DOWN
ATM0/1/2      0      201    PVC      ATM0/0/1     0      201    Tx      DOWN
ATM0/1/2      0      202    PVC      ATM0/0/1     0      202    Tx      DOWN
ATM0/1/2      0      300    PVC      ATM0/0/1     0      300    Tx      DOWN
ATM0/1/2      0      301    PVC      ATM0/0/1     0      301    Tx      DOWN
```

The following example shows the VC snoop connection 0, 55 on ATM interface 0/0/2 in extended mode with the switch processor feature card installed:

```
Switch> show atm snoop-vc interface atm 0/0/2 0 55
Interface: ATM0/0/2, Type: oc3suni
VPI = 0  VCI = 55
Status: DOWN
Time-since-last-status-change: 00:01:59
Connection-type: PVC
Cast-type: snooping-leaf
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/1/1, Type: oc3suni
Cross-connect-VPI = 0
Cross-connect-VCI = 5
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 6, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 3
Rx service-category: VBR-RT (Realtime Variable Bit Rate)
Rx pcr-clp01: 424
Rx scr-clp01: 424
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 3
Tx service-category: VBR-RT (Realtime Variable Bit Rate)
Tx pcr-clp01: 424
Tx scr-clp01: 424
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

The following example shows all VP snoop connections on the ATM switch router:

```
Switch> show atm snoop-vp
      Snooping                    Snooped
Interface    VPI   Type    X-Interface  X-VPI Dir    Status
ATM0/1/2     57    PVP     ATM0/0/1     57    Tx     DOWN
```

The following example shows all VP snoop connections on ATM interface 0/1/2, VPI = 57, in extended mode with the switch processor feature card installed:

```
Switch> show atm snoop-vp interface atm 0/1/2 57
Interface: ATM0/1/2, Type: oc3suni
VPI = 57
Status: DOWN
Time-since-last-status-change: 00:14:46
Connection-type: PVP
Cast-type: snooping-leaf
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/0/2, Type: oc3suni
Cross-connect-VPI = 57
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
Tx connection-traffic-table-index: 1
Tx service-category: UBR (Unspecified Bit Rate)
Tx pcr-clp01: 7113539
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Input Translation Table Management

The Input Translation Table (ITT) is a data structure used in the switch fabric chipsets for the Catalyst 8540MSR, Catalyst 8510MSR, LightStream1010, and 6400 NSP1 platforms. It is used in the handling of input cells. The ITT can be allocated in blocks of entries, each ITT block is dedicated to a VPI on a switch port. The size of ITT blocks must be a power of two. Because the size of the ITT memory is limited, and blocks may be large, allocation of ITT space can be a constraint in configuring new VCs/VPs, and in installing connections at startup and after interface flaps.

Feature Overview

1. The Input Translation Table Management feature improves the use of ITT resources by:
   - Minimizing fragmentation
   - Shrinking ITT blocks
   - Viewing used, and unused ITT blocks

2. For each direction of a transit VP or VC installed in the hardware, there is an entry in the ITT.
3. If the VPI is valid, the entry in the look-up table maps to either a single ITT entry, in the case of transit VP, or to a block of ITT, in the case of a VPI that consists of transit VCs.

   For the Catalyst 8510 MSR, the LightStream 1010, and the 6400NSP1, the ITT is implemented as two banks of 32,000 entries each.

   The ITT is a hardware data structure designed to handle incoming cells. The ITT consists of entries that, for Virtual Circuit (VC) switching, are allocated in contiguous blocks, and each block is dedicated to a Virtual Path Identifier (VPI) on an interface. ITT functionality is used only when both interfaces through which the VC transits are up.

VC Block Allocation

Interfaces must be up in order for connections to be installed in hardware. No connections are installed for interfaces that are down (either as a result of an administrative shutdown or because the physical interface is down). Only cross-connects are installed in hardware (PVC/PVP legs that are not cross-connected are not installed), and the installation only occurs in both interfaces participating in the cross-connect are up.

No ITT space is allocated for connections that are not installed in hardware; shutting down an interface releases all ITT blocks allocated for input from that interface.

Freeing an ITT Block

When an ITT block is freed, an attempt is made to combine it with a same-size ITT block already in the free-pool, thereby resulting in a block of a size qualifying for the next-largest category on the free-chain list. This process (attempting to combine blocks) is continued up the list until a match is no longer found; however, blocks are not merged across the 16K VP support line.

Growing an ITT Block

When a request occurs for a new VC in a VPI, and the VCI exceeds the size of the current ITT block, it is possible to expand the size of the ITT block, without significant service interruption. To do this, software allocates a new block of the desired size, copies the entries found in the small block to the large block, modifies the LUT to point to the new block, and frees the small block.

On LightStream 1010 platforms, the process of combining ITT blocks is restricted to same-bank blocks; the new block must reside in the same bank as the old block (similar to the way that other hardware data structures are “banked”).

ITT Fragmentation

ITT memory can become fragmented as blocks are allocated, grow, and are freed; blocks then consist of numerous used and free memory sections, of varying sizes. Under such circumstances, the aggregate amount of free memory can be significantly larger than the capacity of the largest single block.

Benefits

The primary benefits of the ITT management feature are:

- Reduced fragmentation in ITT blocks

- Capability to display ITT allocation
- Capability to autoshrink ITT blocks

Reducing ITT Fragmentation

It is important to make adjustments to the VC configuration processing, both at initial boot-up and in response to interface flaps. Optimal-size ITT blocks will be allocated on the first pass, and eliminate fragmentation due to sequentially growing the ITT blocks.

System and Startup ITT Fragmentation

Two sources of ITT fragmentation are the way that configured connections are installed in hardware upon startup and the way they are installed when an interface comes up.

When a startup configuration file is created (e.g. entering the **write terminal** command), the PVC cross-connect definitions are specified in the file in ascending order by interface, first addressing VPIs, and then VCIs (choosing one interface of a PVC as the source). This is the order in which they are processed when the system reads the file at startup. If the interface is considered up when the startup configuration is read, the VCI values in a VPI are allocated starting with the low values and proceeding to the high values; this can result in a series of steps that contribute to the growth of the ITT block used by the VPI.

Whether or not interfaces are up at startup, the startup configuration software creates data structures representing the PVCs specified in the startup configuration file.

Following a similar procedure, these data structures also order the PVCs by VPI, then VCI, and allocations start with the low values and proceed to the high values.

Whenever an interface comes up, connection management software evaluates each of the connections defined (in data structures) as residing on the interface, to see whether the connection can be brought up. This evaluation also proceeds by VPI, then VCI, and can result in fragmentation due to growth of the ITT blocks.

Solution: Minimum block-size per-VPI

The remedy proposed is to provide hints in configuration for the minimum ITT block size to allocate when allocating a block for a VPI on an interface.

Using the minblock Command to Specify a Minimum Block Size

Use the **minblock** command to specify the minimum block size for each VPI on an interface. Use the **force** keyword to specify a minimum ITT block size if **autominblock** mode is not enabled, or to ensure that the block size is not overridden by the **autominblock** mode. The **minblock** command is an interface configuration mode command.

	Command	Purpose
Step 1	Switch(config-if)# **interface slot/subslot/port**	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm input-xlate-table minblock vpi** *vpi-value block-size* **force**	Specifies the minimum block size (as a power of 2) for a VPI. Use the force keyword.

	Command	Purpose
Step 3	Switch(config-if)# **atm input-xlate-table minblock vpi** *vpi-value block-size* **force**	Repeats this command for as many VPIs are required.
Step 4	Switch(config-if)# **exit**	Returns to global configuration mode.

The CLI-specified non-force **minblock** interface configuration command is overridden when one or more of the following four conditions are present:

- When the minblock command is processed and the existing PVCs on the interface are sufficient to require, at a minimum, the block size specified in the CLI command. (Under these circumstance, the block size is subsequently determined by analysis, rather than the CLI value.)
- When a VC is added to the interface/VPI referred to by the CLI command, and requires, at a minimum, the block size specified in the CLI command. (Under these circumstances, the block size is subsequently determined by analysis).
- When a VC is deleted from the interface/VPI referred to by the CLI command. (Under these circumstances, the block size is subsequently determined by analysis.
- When a nonvolatile-generation operation is performed (e.g. initiated by entering the write terminal command).

Using the Autominblock Command to Enable the Minimum Mode

Use the **autominblock** command to enable the automatic analysis of minimum ITT needs of each interface/VPI in the system. The system uses this information for a subsequent ITT request, and specifies minimum block sizes in startup configuration generation via the insertion of minblock commands. This is a global configuration mode command.

Command	Purpose
Switch(config)# **atm input-xlate-table autominblock**	Specifies autominblock mode.

On initial configuration of the **atm input-xlate-table autominblock** command, ITT memory may already be somewhat fragmented due to previous commands.

The effect of the fragmentation can be minimized by configuring, when first using the VPI, a cross-connect that uses the maximum VCI on a VPI. Note, however, that this should not be considered the best everyday practice; in general, for effective automatic determination of minimum block size on a VPI, a PVC should be configured by using the planned maximum VCI on a VPI.

When autominblock mode is disabled (via use of the **no** form of the command), all previously entered minblock configuration commands entered without the **force** keyword are lost.

Unless one of the **atm input-xlate-table** configuration commands is entered, the system operates as it did prior to these enhancements.

Whether or not the **atm input-xlate-table autominblock** configuration is in effect, the user can configure **atm input-xlate-table minblock** for interface/VPIs, (if the **force** keyword is used). The affect of the **minblock** command in the various situations in which it can be used is shown in Table 7-5:

Table 7-5 autominblock-force minblock Interaction Matrix

autominblock mode enabled	force minblock with command keyword used	Effect
True	True	Command accepted; value rounded up and used as block-size hint, value not overridden by automatic analysis; value will be nvgened.
True	False	Command accepted; value rounded up used as a floor for block-size hint; value may be overridden by automatic analysis; value not necessarily nvgened.
False	True	Command accepted; value rounded up and used as block-size hint; value will be nvgened
False	False	Command not accepted.

Shrinking ITT Block Size

Natively, an ITT block will grow as necessary to accommodate higher VCIs on a given port/VPI, but will not automatically shrink as the high-numbered VCIs are removed from the configuration. An allocated ITT block will be freed if it has only one member VC, and that member VC is deleted; if one member VC is deleted but one or more other VCs still uses the block, the block retains its previously allocated size.

Two advantages of this process are the amount of time and processing required. It requires less processing time and resources, since blocks are not evaluated for size reduction, and preserving the block size facilitates the subsequent addition of other VCs to the block. In addition, if it does become necessary to resize the block, entering the **shutdown/no shutdow**n command sequence on the interface will release ITT space, and a smaller block will be allocated.

When high-numbered VCs are deleted from the configuration, use the autoshrink global configuration command to shrink an ITT block in-place and release the unused ITT resources.

Command	Purpose
Switch(config)# **atm input-xlate-table autoshrink**	Specifies autoshrink mode.

The autoshrink command and minblock/autominblock commands have the different effects on the system. When autominblock is disabled and no minblock commands are outstanding, as VCs are deleted, the autoshrink feature reduces ITT use of VCs that are sharing a VPI. The minblock commands specify a minimum desired block size

Displaying ITT resources

The non-privileged EXEC mode command **show atm input-xlate-table** provides a comprehensive view of ITT utilization, including the blocks that are used and available, and the ports at which the blocks are allocated. The output of the command shows details of the free blocks by size and bank, the aggregate remaining free space, and the location of blocks that are in use.

Command	Purpose
Switch# **show atm input-xlate-table**	Displays a list of the ITT blocks that are in use.

When you use the **show** command with the **inuse** keyword, the output of the command shows a detailed list of in-use blocks, by the port/VPI to which they are dedicated.

Command	Purpose
Switch# **show atm input-xlate-table inuse**	Displays ITT blocks in use.

Configuration Examples

This section shows two examples of the **show atm input-xkate-table** command.

Example (LightStream1010 and 6400 NSP1)

show atm input-xlate-table [inuse]
Use this nonprivileged exec mode command to display ITT usage details. The output of the unqualified command, (without the **inuse** keyword) shows detail of the free blocks by size and bank, the aggregate free space, and the location of the blocks that are in use. The output of the command with the **inuse** keyword show remaining a detailed list of the blocks that are in use, and lists them the by port/VPI to which they are dedicated.

The output of the unqualified command (without the **inuse** keyword) is:

```
switch# show atm input-xlate-table
Input Translation Table Free Blocks:
 Block-start   Size     Bank
 1             1         0
 2             2         0
 4             4         0
 8             8         0
 16            16        0
 32            32        0
 64            64        0
 17408         64        0
 128           128       0
 17536         128       0
 256           256       0
 17664         256       0
 512           512       0
 17920         512       0
 1024          1024      0
 2048          2048      0
 18432         2048      0
 4096          4096      0
 20480         4096      0
 8192          8192      0
 24576         8192      0
 32769         1         1
 32770         2         1
 32772         4         1
 32776         8         1
 32784         16        1
 32800         32        1
 49248         32        1
 32832         64        1
 49152         64        1
 49344         64        1
 32896         128       1
 33024         256       1
 49408         256       1
 33280         512       1
 49664         512       1
 33792         1024      1
 50176         1024      1
 34816         2048      1
 51200         2048      1
 36864         4096      1
 53248         4096      1
 40960         8192      1
 57344         8192      1

Input Translation Table Total Free = 64350

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size
 0             0             1
 16384         17407         1024
 17472         17535         64
 32768         32768         1
 49216         49247         32
 49280         49343         64
```

The output of the command with the **inuse** keyword is:

```
switch# show atm input-xlate-table inuse
switch# show atm input inuse
Interface        VPI  VP/VC Address  Size
ATM0/1/0         0      VC  17472    64
ATM0/1/0         2      VP  32768    1
ATM0/1/2         0      VC  49216    32
ATM0/1/2         2      VP  0        1
ATM1/0/0         0      VC  49280    64
ATM1/0/0         9      VC  16384    1024
```

Example (Catalyst 8540 MSR)

show atm input-xlate-table [module-id *module*] [inuse]

Where *module* is a value 1-8.

```
The Catalyst 8540 MSR form of the show command must show ITT utilization for one or all of
the modules of the system.
```

The output of the unqualified command (without the **inuse** keyword) is:

```
switch# show atm input
Module 1 Input Translation Table Free Blocks:
 Block-start   Size
 64            64
 1280          128
 128           128
 256           256
 512           512
 3072          1024
 6144          2048
 8192          8192
 16384         16384

Input Translation Table Total Free = 28736

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size
 0             63            64
 1024          1279          256
 1408          3071          1664
 4096          6143          2048

===============================================
Module 2 Input Translation Table Free Blocks:
 0             1024
 1024          1024
 2048          2048
 4096          4096
 8192          8192
 16384         16384

Input Translation Table Total Free = 32768

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size

===============================================
Module 3 Input Translation Table Free Blocks:
 Block-start   Size
 64            64
 128           128
 1408          128
 256           256
 512           512
 1536          512
 2048          1024
 8192          8192

Input Translation Table Total Free = 12864

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size
 0             63            64
 1024          1407          384
 3072          6143          3072
 16384         32767         16384

===============================================
Module 4 Input Translation Table Free Blocks:
 Block-start   Size
 0             1024
 1024          1024
```

```
 2048          2048
 4096          4096
 8192          8192
 16384         16384

Input Translation Table Total Free = 32768
Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size

===============================================
Module 5 Input Translation Table Free Blocks:
 Block-start   Size
 1024          128
 1280          256
 1536          512
 0             1024
 2048          2048
 4096          4096
 8192          8192
 16384         16384

Input Translation Table Total Free = 32640

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size
 1152          1279          128

===============================================
 Block-start   Size
 1024          1024
 0             1024
 2048          2048
 4096          4096
 8192          8192
 16384         16384

Input Translation Table Total Free = 32768

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size

===============================================
Module 6 Input Translation Table Free Blocks:
 Block-start   Size
 0             1024
 1024          1024
 2048          2048
 4096          4096
 8192          8192
 16384         16384
Input Translation Table Total Free = 32768

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size

===============================================
Module 7 Input Translation Table Free Blocks:
 Block-start   Size
 0             1024
 1024          1024
 2048          2048
 4096          4096
 8192          8192
 16384         16384
```

```
Input Translation Table Total Free = 32768

Input Translation Table In Use (display combines contiguous blocks):
 Inuse-start   Inuse-end   Size

===============================================
```

The output of the command with the **inuse** keyword is:

```
switch# show atm input inuse
Module Interface        VPI  VP/VC Address Size  VP-inuse
 0       *               *      VP  0       64      1
 0      ATM0/1/0         3      VC  1536    512
 0      ATM0/1/0         4      VC  4096    2048
 0      ATM0/1/0         5      VC  2048    1024
 0      ATM0/1/0         0      VC  1024    256
 0      ATM4/0/0         0      VC  1408    128
 2       *               *      VP  0       64      1
 2      ATM2/0/0         2      VC  3072    1024
 2      ATM2/0/0         3      VC  1280    64
 2      ATM2/0/0         0      VC  1024    256
 2      ATM2/0/2         2      VC  4096    2048
 2      ATM2/0/2         3      VC  16384   16384
 2      ATM2/0/2         0      VC  1344    64
 4      ATM8/0/0         0      VC  1152    128
```

Configuring Operation, Administration, and Maintenance

This chapter describes the Operation, Administration, and Maintenance (OAM) implementation on the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

OAM Overview

OAM performs fault management and performance management functions at the ATM management (M)-plane layer.

Note Current OAM implementation supports only the fault management function, which includes connectivity verification and alarm surveillance.

The ATM switch router has full support for the following ATM OAM cell flows:

- F4 flows—OAM information flows between network elements (NEs) used within virtual paths to report an unavailable path or a virtual path (VP) that cannot be guaranteed.
- F5 flows—OAM information flows between network elements (NEs) used within virtual connections to report degraded virtual channel (VC) performance such as late arriving cells, lost cells, and cell insertion problems.

Both F4 and F5 flows can be configured as either end-to-end or segment-loopback and used with alarm indication signal (AIS) and remote defect indication (RDI) functions. An AIS is a signal transmitted downstream informing the destination that an upstream failure has been detected. An RDI signal indicates that a failure has occurred at the far end of an ATM network.

Note Cells can be sent either on demand or periodically to verify link and connection integrity.

In addition to the standard OAM functions, the ATM switch router can also send OAM pings. OAM cells containing the ATM node addresses or IP addresses of intermediate switches allow network administrators to determine the integrity of a chosen connection at any intermediate point along the connection, allowing for network connection debugging and troubleshooting.

OAM software implements ATM Layer F4 and F5 OAM fault management functions. OAM performs standard loopback (end-to-end or segment) and fault detection and notification (AIS and RDI) for each connection. It also maintains a group of timers for the OAM functions. When there is an OAM state change such as loopback failure, OAM software notifies the connection management software.
The network operator can enable or disable OAM operation for the following switch components:

- The entire switch
- A specific ATM interface
- A specific ATM connection

If OAM operation is disabled, outgoing OAM cells (AIS, RDI and loopbacks) are not generated and AIS and RDI cells that arrive at connection endpoints are discarded.

To support various OAM operations, the ATM switch router hardware provides OAM cell routing functions on a per-connection basis for each direction and for different OAM cell spans (segment and end-to-end). The hardware OAM cell routing determines the destination of an OAM cell received from the link or the network and then determines whether OAM cells are processed by the switch software.

The hardware can perform the following functions on OAM cells:

- Intercept—Intercepted to the CPU queue and processed by the ATM switch router software
- Relay—Relayed along with user cell by hardware without any software processing
- Discard—Discarded by hardware

An ATM connection consists of a group of network points that form the edges of each ATM switch or end system.

Each point can be one of the following:

- Connection end point—The end of a connection where the user ATM cells are terminated
- Segment end point—The end of a connection segment
- Connecting point—The middle point of a connection segment

The following sections describe the OAM tasks:

- Configuring OAM Functions, page 8-3
- Checking the ATM Connection (Catalyst 8540 MSR), page 8-5
- Checking the ATM Connection (Catalyst 8510 MSR and LightStream 1010), page 8-5
- Displaying the OAM Configuration, page 8-6

Configuring OAM Functions

This section describes OAM commands in EXEC, global, and interface configuration mode.

Configuring OAM for the Entire Switch (Catalyst 8540 MSR)

To enable OAM operations for the Catalyst 8540 MSR, use the global configuration command, as shown in the following table:

Command	Purpose
atm oam [**ais**] [**end-loopback**] [**max-limit** *number*] [**rdi**] [**seg-loopback**]	Enables or disables OAM operations for the entire switch.

Note The number of maximum OAM configured connections allowed ranges from 1 to 3200; the default is 3200.

Examples

The following example shows how to enable AIS and segment loopback for the entire switch:

```
Switch(config)# atm oam ais seg-loopback
% OAM: Switch level seg loopback is enabled

% OAM: Switch level ais is enabled
```

The following example shows how to configure the ATM OAM connection maximum to 1600:

```
Switch(config)# atm oam max-limit 1600
```

Configuring OAM for the Entire Switch (Catalyst 8510 MSR and LightStream 1010)

To enable OAM operations for the entire Catalyst 8510 MSR and LightStream 1010 ATM switch router, use the global configuration command, as shown in the following table:

Command	Purpose
atm oam [**ais**] [**end-loopback**] [**intercept end-to-end**] [**max-limit** *number*] [**rdi**] [**seg-loopback**]	Enables or disables OAM operations for the entire switch.

Note The number of maximum OAM configured connections allowed ranges from 1 to 3200; the default is 3200.

Examples

The following example shows how to enable AIS and segment loopback for the entire switch:

```
Switch(config)# atm oam ais seg-loopback
% OAM: Switch level seg loopback is enabled

% OAM: Switch level ais is enabled
```

The following example shows how to configure the ATM OAM connection maximum to 1600:

```
Switch(config)# atm oam max-limit 1600
```

Configuring the Interface-Level OAM

To enable OAM operations on an interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm oam** [**interface atm** *card***/***subcard***/***port*[**.***vpt#*]] [*vpi* [*vci*]] [**ais**] [**end-loopback**] [**rdi**] [**seg-loopback**]	Configures interface OAM operations.
Step 3	Switch(config-if)# **atm oam** *vpi* [*vci*] **loopback-timer** *tx-timer-value*	Configures the OAM loopback transmit timer.

Examples

The following example shows how to enable OAM AIS and end-to-end loopback on interface 3/0/0:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm oam ais end-loopback
% OAM: Interface level end to end loopback is enabled

% OAM: Interface level ais is enabled
```

The following example shows how to enable OAM AIS and end-to-end loopback on interface 3/0/0, VPI = 50, VCI = 100:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm oam 50 100 ais end-loopback
% OAM: Connection level end to end loopback is enabled

% OAM: Connection level ais is enabled
```

Note You can use only VPI values to configure OAM operations on VP connections.

In interface configuration command mode, you can enable or disable OAM operations on existing connections on different interfaces by specifying **interface atm** *card***/***subcard***/***port*. The following example disables OAM AIS flows at interface 1/0/0 while in interface 3/0/0:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# no atm oam interface atm 1/0/0 ais
% OAM: Interface level ais is disabled
```

Checking the ATM Connection (Catalyst 8540 MSR)

To check ATM connection reachability and network connectivity on the Catalyst 8540 MSR, use the **ping** EXEC command, as shown in the following table:

Command	Purpose
ping atm interface atm *card/subcard/port vpi* [*vci*] {**end-loopback** [*destination*] | **seg-loopback** [*destination*]}	Checks the connection.

You can ping a neighbor switch by selecting the segment loopback option. In privileged EXEC mode, you can select various other parameters such as repeat count and timeout values.

Examples

The following example shows the **ping** command used in normal mode to check a virtual channel connection (VCC) with a segment loopback flow:

```
Switch# ping atm interface atm 3/0/0 50 100 seg-loopback

Type escape sequence to abort.
Sending Seg-Loopback 5, 53-byte OAM Echoes to a neighbor, timeout is 5 seconds:
.....
Success rate is 0 percent (0/5)
```

The following example shows the **ping** command used in extended mode to check a VCC with end-to-end loopback flow:

```
Switch# ping
Protocol [ip]: atm
Interface [card/sub-card/port]: 3/0/0
VPI [0]: 0
VCI [0]: 16
Send OAM-Segment-Loopback ? [no]:
Target IP address:
Target NSAP Prefix:
Repeat count [5]:
Timeout in seconds [5]:
Type escape sequence to abort.
Sending end-Loopback 5, 53-byte OAM Echoes to a connection end point, timeout is
 5 seconds:
.....
Success rate is 0 percent (0/5)
```

Checking the ATM Connection (Catalyst 8510 MSR and LightStream 1010)

To check ATM connection reachability and network connectivity on the Catalyst 8510 MSR and LightStream 1010 ATM switch router, use the **ping** EXEC command, as shown in the following table:

Command	Purpose
ping atm interface atm *card/subcard/port vpi* [*vci*] {[**atm-prefix** *prefix*] | **end-loopback** [*destination*] | **ip-address** *ip-address* | **seg-loopback** [*destination*]}	Checks the connection.

You can use either an ATM address prefix or an IP address as a ping destination. You can ping a neighbor switch by selecting the segment loopback option. In privileged EXEC mode, you can select various other parameters such as repeat count and timeout values.

Examples

The following example shows the **ping** command used in normal mode to check a VCC with a segment loopback flow:

```
Switch# ping atm interface atm 3/0/0 50 100 seg-loopback

Type escape sequence to abort.
Sending Seg-Loopback 5, 53-byte OAM Echoes to a neighbor, timeout is 5 seconds:
.....
Success rate is 0 percent (0/5)
```

The following example shows the **ping** command used in extended mode to check a VCC with end-to-end loopback flow:

```
Switch# ping
Protocol [ip]: atm
Interface [card/sub-card/port]: 3/0/0
VPI [0]: 0
VCI [0]: 16
Send OAM-Segment-Loopback ? [no]:
Target IP address:
Target NSAP Prefix:
Repeat count [5]:
Timeout in seconds [5]:
Type escape sequence to abort.
Sending end-Loopback 5, 53-byte OAM Echoes to a connection end point, timeout is
 5 seconds:
.....
Success rate is 0 percent (0/5)
```

Note If you do not enable the OAM segment loopback option, the **ping** command uses an OAM end-to-end loopback cell. If you do not provide a target address, the connection end point becomes the target.

Displaying the OAM Configuration

To display the OAM configuration, use the following EXEC command:

Command	Purpose
more system:running-config	Displays the OAM configuration.

Example

The OAM configuration is displayed in the following example:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
boot system flash slot0:rhino/ls1010-wi-m_1.083.bin.Z
!
ip rcmd remote-username doug
atm oam max-limit 1600
atm over-subscription-factor 16
atm service-category-limit cbr 3000
atm qos uni3-default  cbr max-cell-loss-ratio 12
atm lecs-address 47.0091.0000.0000.0000.0000.0000.0000.0000.0000.00
atm address 47.0091.8100.0000.0060.3e5a.db01.0060.3e5a.db01.00
!
interface ATM0/0/0
 no keepalive
 map-group atm-1
 no atm auto-configuration
 no atm address-registration
 no atm ilmi-enable
 no atm ilmi-lecs-implied
 atm iisp side user
 atm pvp 99
 atm oam 0 5 seg-loopback  end-loopback  rdi
 atm oam 0 16 seg-loopback  end-loopback  rdi
 atm oam 0 18 seg-loopback  end-loopback  rdi
!
interface ATM0/0/0.99 point-to-point
 no atm auto-configuration
 no atm address-registration
 no atm ilmi-enable
 no atm ilmi-lecs-implied
 atm maxvp-number 0
 atm oam 99 5 end-loopback  rdi
 atm oam 99 16 end-loopback  rdi
 atm oam 99 18 end-loopback  rdi
!
--More--

<information deleted>
```

Configuring Resource Management

This chapter describes resource management, which involves modeling and managing switch, interface, and connection resources. Such resources include equivalent bandwidth and buffering to support the provision of specified traffic classes.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For detailed descriptions of traffic management mechanisms and their operation, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Note The traffic and resource management features of the ATM switch router are presented in a different order in this guide and in the *Guide to ATM Technology*. In this guide the sequence of features follows configuration scope and proceeds from global to per-interface features. In the *Guide to ATM Technology* the sequence of features follows the phases of a connection and proceeds from traffic contract to management of hardware resources.

Resource Management Functions

The ATM switch router resource management software provides the following functions:

- Network management interface—Includes operational configuration changes (take place immediately), proposed configuration changes (take place on restart), user interface, and status.
- Default quality of service (QoS) objective table management—Since User-Network Interface 3 (UNI 3) signalling does not provide information elements to signal QoS values, resource management provides a table that contains default values for QoS.
- Connection Traffic Table (CTT) management—Rather than store traffic parameters for each connection in that connection's data structure, resource management manages a table of connection traffic parameters, used by network and connection management.
- Hardware resource management (Catalyst 8540 MSR)—The switch processor feature card provides functionality that include statistic collection, and traffic policing usage parameter control (UPC). See Configuring Global Resource Management, page 9-4 for detailed information.
- Hardware resource management (Catalyst 8510 MSR and LightStream 1010)—Different sets of functionality are available with feature card per-class queueing (FC-PCQ) and feature card per-flow queueing (FC-PFQ). FC-PCQ features include switch cell priority limits, interface queue sizes, and thresholds. FC-PFQ features include threshold group configuration. The interface pacing feature is available with both feature cards. See Processor Feature Card Functionality (Catalyst 8510 MSR and LightStream 1010), page 9-3 for detailed information.
- Resource Call Admission Control (RCAC)—Determines whether a virtual channel connection/virtual path connection (VCC/VPC) can be admitted (allowed to be set up), based on the available connection resources and requested traffic characteristics.
- Logical interface creation and deletion.
- Private Network-Network Interface (PNNI) metrics—resource management supplies PNNI with link metrics for connection routing.

Switch Fabric Functionality (Catalyst 8540 MSR)

The switch fabric for the Catalyst 8540 MSR provides the required ATM Forum Traffic Management features as described in Table 9-1.

Table 9-1 Switch Processor Feature Card

Feature	Description
Traffic classes:	CBR[1], VBR-RT[2], VBR-NRT[3], UBR[4], ABR[5](EFCI)[6]
Output queuing	Per-VC or per-VP
Output scheduling	RS[7] and WRR[8]
Intelligent early packet discard	Multiple dynamic thresholds
Intelligent tail (partial) packet discard	Supported
Selective cell marking and discard	Multiple, weighted, dynamic thresholds

Table 9-1 Switch Processor Feature Card (continued)

Feature	Description
Shaping	Per-port pacing, per-CBR VC, per-CBR transit VP, per-shaped CBR VP tunnel (128 shaped VP tunnels total), and hierarchical VP tunnels
Policing (UPC[9])[10]	Dual leaky bucket
Frame mode VC-merge	Supported
Point-to-multipoint VC (multicast)	Multiple leafs per output port, per point-to-multipoint
Network clock switchover[10]	Programmable clock selection criteria
Nondisruptive snooping	Per-VC or per-VP
Hierarchical VP tunnel	Maximum of 240 VP tunnels.

1. CBR = constant bit rate
2. VBR-RT = variable bit rate real time
3. VBR-NRT = variable bit rate non-real time
4. UBR = unspecified bit rate
5. ABR = available bit rate
6. EFCI = explicit forward congestion indication
7. RS = rate scheduling
8. WRR = weighted round-robin
9. UPC = usage parameter control
10. Performed by feature card

Processor Feature Card Functionality (Catalyst 8510 MSR and LightStream 1010)

Two types of feature cards are available for the Catalyst 8510 MSR and LightStream 1010 ATM switch routers: FC-PCQ and FC-PFQ. Each card provides the required ATM Forum Traffic Management features. FC-PCQ contains a subset of the FC-PFQ features, as described in Table 9-2.

Note To determine which feature card you have installed, enter the **show hardware** EXEC command. Either FeatureCard1, for FC-PCQ, or FC-PFQ displays in the Ctrlr-Type column.

Table 9-2 FC-PCQ and FC-PFQ Feature Comparison

Feature	FC-PCQ	FC-PFQ
Traffic classes	CBR[1], VBR-RT[2], VBR-NRT[3], ABR[4] (EFCI[5] and RR[6]), UBR[7]	CBR, VBR-RT, VBR-NRT, ABR (EFCI and RR), UBR
Output queuing	Four classes per port	Per-VC or per-VP
Output scheduling	SP[8]	RS[9] and WRR[10]
Intelligent early packet discard	Multiple fixed thresholds	Multiple dynamic thresholds

Table 9-2 FC-PCQ and FC-PFQ Feature Comparison (continued)

Feature	FC-PCQ	FC-PFQ
Intelligent tail (partial) packet discard	Supported	Supported
Selective cell marking and discard	Multiple fixed thresholds	Multiple, weighted, dynamic thresholds
Shaping	Per-port (pacing)	Per-port pacing, per-CBR VC, per-CBR transit VP, per-shaped CBR VP tunnel (128 shaped VP tunnels total), and hierarchical VP tunnels
Policing (UPC[11])	Dual mode, single leaky bucket	Dual leaky bucket
Point-to-multipoint VC (multicast)	One leaf per output port, per point-to-multipoint	Multiple leafs per output port, per point-to-multipoint
Network clock switch over	Automatic upon failure	Programmable clock selection criteria
Nondisruptive snooping	Per-port transmit or receive	Per-VC or per-VP
Hierarchical VP tunnel[12]	–	Maximum of 62 VP tunnels

1. CBR = constant bit rate
2. VBR-NT = variable bit rate real time
3. VBR-NRT = variable bit rate non-real time
4. ABR = available bit rate
5. EFCI = explicit forward congestion indication
6. RR = relative rate
7. UBR = unspecified bit rate
8. SP = strict priority
9. RS = rate scheduling
10. WRR = weighted round-robin
11. UPC = usage parameter control
12. Available with FC-PFQ only

Configuring Global Resource Management

Global resource management configurations affect all interfaces on the switch. The following sections describe global resource management tasks:

- Configuring the Default QoS Objective Table, page 9-5
- Configuring the Switch Oversubscription Factor (Catalyst 8510 MSR and LightStream 1010), page 9-6
- Configuring the Service Category Limit (Catalyst 8510 MSR and LightStream 1010), page 9-7
- Configuring the ABR Congestion Notification Mode (Catalyst 8510 MSR and LightStream 1010), page 9-8
- Configuring the Connection Traffic Table, page 9-10

- Configuring the Sustainable Cell Rate Margin Factor, page 9-13
- Overview of Threshold Groups, page 9-14

Configuring the Default QoS Objective Table

Resource management provides a table of default objective values for quality of service (QoS) for guaranteed service categories. These values—either metrics or attributes—are used as the criteria for connection setup requirements.

> **Note** Default objective values for QoS for guaranteed service categories can be configured for UNI 4.0 signalling.

Table 9-3 lists the default values of the QoS objective table.

Table 9-3 Default QoS Objective Table Row Contents

Service Category	Max Cell Transfer Delay (clp01)	Peak-to-Peak Cell Delay Variation (clp01)	Cell Loss Ratio (clp0)	Cell Loss Ratio (clp0+1)
CBR	Undefined	Undefined	Undefined	Undefined
VBR-RT	Undefined	Undefined	Undefined	Undefined
VBR-NRT	—	—	Undefined	Undefined

Each objective can have a defined or undefined value. If undefined, the objective is not considered in connection setup. The table should be configured with the same values for an entire network.

To configure the default QoS objective table, perform the following tasks in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm qos default** {**cbr** | **vbr-rt**} **max-cell-transfer-delay** {*microseconds* | **any**}	Selects the ATM QoS default CBR or VBR-RT maximum cell transfer delay.
Step 2	Switch(config)# **atm qos default** {**cbr** | **vbr-rt**} **peak-to-peak- cell-delay variation** {*microseconds* | **any**}	Selects the ATM QoS default CBR or VBR-RT peak-to-peak cell delay variation.
Step 3	Switch(config)# **atm qos default** {**cbr** | **vbr-rt** | **vbr-nrt**} **max-cell-loss-ratio** [**clp0** | **clp1plus0**] {*loss-ratio-exponent* | **any**}	Selects the ATM QoS default CBR, VBR-RT, or VBR-NRT maximum cell loss ratio.

Example

The following example shows how to change the constant bit rate (CBR) maximum cell loss ratio objective for cell loss priority (CLP) = 0+1 to 10^{-12} cells per second:

```
Switch(config)# atm qos default cbr max-cell-loss-ratio clp1plus0 12
```

Displaying the ATM QoS Objective Table

To display the default QoS objective table, use the following EXEC command:

Command	Purpose
show atm qos-defaults	Displays the ATM QoS objective table configuration.

The per-service category, maximum cell transfer delay, peak-to-peak cell delay variation, and maximum cell loss ratio objectives are displayed.

Example

The ATM QoS objective table configuration is displayed in the following example:

```
Switch> show atm qos-defaults
Default QoS objective table:
    Max cell transfer delay (in microseconds): any cbr, any vbr-rt
    Peak-to-peak cell  delay variation (in microseconds): any cbr, any vbr-rt
    Max cell loss ratio for CLP0 cells: any cbr, any vbr-rt, any vbr-nrt
    Max cell loss ratio for CLP0+1 cells:  10**(-12) cbr, any vbr-rt, any vbr-nrt
```

Configuring the Switch Oversubscription Factor (Catalyst 8510 MSR and LightStream 1010)

The switch oversubscription factor (OSF) feature on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers is used in determining initial port maximum queue sizing for variable bit rate non-real time (VBR-NRT) and available bit rate/unspecified bit rate (ABR/UBR) queues.

Note Over subscription factor configuration is only possible on switches with FC-PCQ installed.

The size of the VBR-NRT queue and ABR/UBR queues is determined by the following equations, where the default size of the CBR and VBR-RT queues vary by interface type, as listed in Table 9-4:

```
Default Size (VBR-NRT) = 0.25 * ((OSF * 2048) - DefaultSize(CBR) - DefaultSize (VBR-RT))
Default Size (ABR-UBR) = 0.75 * ((OSF * 2048) - DefaultSize(CBR) - DefaultSize (VBR-RT))
```

Table 9-4 Default CBR and VBR Determined by Interface Type

Interface Type	Default Max Size CBR Queue	Default Max Size Type VBR-RT Queue
SONET	256	256
DS3/E3	256	512

To configure the OSF, use the following global configuration command:

Command	Purpose
atm over-subscription-factor *o-value*	Configures the switch OSF from 1 to 32.

Note This value can be changed at any time, but it is only used at start-up and when a module is hot-swapped from the chassis.

Example

The following example shows how to set the switch oversubscription factor to 16:

```
Switch(config)# atm over-subscription-factor 16
```

Displaying the OSF Configuration (Catalyst 8510 MSR and LightStream 1010)

To display the OSF configuration, use the following EXEC command:

Command	Purpose
show atm resource	Displays the OSF configuration.

Note The following examples differ depending on the feature card installed in your switch.

Examples

The following example shows the switch OSF configuration with FC-PCQ installed:

```
Switch> show atm resource
Resource configuration:
    Over-subscription-factor 16  Sustained-cell-rate-margin-factor 1%
    Abr-mode:   relative-rate
    Atm service-category-limit (in cells):
         64544 cbr 64544 vbr-rt 64544 vbr-nrt 64544 abr-ubr
Resource state:
    Cells per service-category:
         0 cbr 0 vbr-rt 0 vbr-nrt 0 abr-ubr
```

Configuring the Service Category Limit (Catalyst 8510 MSR and LightStream 1010)

The service category limit configuration restricts the number of cells admitted into the switch, as determined by the type of output queues.

Note Service category limit configuration is only possible on switches with FC-PCQ installed.

Caution Setting a service category limit to 0 causes the connection requests for the associated service categories to be rejected.

To configure the service category limits, use the following global configuration command:

Command	Purpose
atm service-category-limit {**cbr** | **vbr-rt** | **vbr-nrt** | **abr-ubr**} *value*	Configures ATM service category limits for a specific output queue.

Note The **atm service-category-limit** command affects all connections, including those already established.

Example

The following example shows how to change the service category limit for the CBR cells within the switch fabric to 3000 cells:

```
Switch(config)# atm service-category-limit cbr 3000
```

Displaying the Service Category Limit Configuration (Catalyst 8510 MSR and LightStream 1010)

To display the service category limit configuration, use the following EXEC command:

Command	Purpose
show atm resource	Displays the service category limits configuration.

Example

The following example shows the service category limits configuration:

```
Switch> show atm resource
Resource configuration:
    Over-subscription-factor 16  Sustained-cell-rate-margin-factor 1%
    Abr-mode:   relative-rate
➔   Atm service-category-limit (in cells):
         3000 cbr 64544 vbr-rt 64544 vbr-nrt 64544 abr-ubr
Resource state:
    Cells per service-category:
         0 cbr 0 vbr-rt 0 vbr-nrt 0 abr-ubr
```

Configuring the ABR Congestion Notification Mode (Catalyst 8510 MSR and LightStream 1010)

The available bit rate (ABR) congestion notification mode changes the type of notification used on ABR connections to alert the end station of congestion. ABR mode configuration determines whether ABR uses explicit forward congestion indication (EFCI) marking, relative-rate marking, or both, for rate management on ABR connections.

The global configuration function is used to modify the ABR mode selection for all ABR connections.

To configure the ABR mode, use the following global configuration command:

Command	Purpose
atm abr-mode {**efci** | **relative-rate** | **all**}	Configures ABR congestion notification mode.

Note The **atm abr-mode** command affects all connections, including those already established.

Example

The following example shows how to configure the entire switch to set the EFCI bit whenever a cell arrives on a congested ABR connection:

```
Switch(config)# atm abr-mode efci
```

Displaying the ABR Congestion Notification Mode Configuration (Catalyst 8510 MSR and LightStream 1010)

To display the ABR congestion notification mode configuration, use the following EXEC command:

Command	Purpose
show atm resource	Displays the ABR congestion notification mode configuration.

Note The following examples differ depending on the feature card installed in your switch.

Examples

The following example shows the ABR mode configuration with FC-PCQ installed:

```
Switch> show atm resource
Resource configuration:
    Over-subscription-factor 16  Sustained-cell-rate-margin-factor 1%
➔   Abr-mode: efci
    Atm service-category-limit (in cells):
         3000 cbr 64544 vbr-rt 64544 vbr-nrt 64544 abr-ubr
Resource state:
    Cells per service-category:
         0 cbr 0 vbr-rt 0 vbr-nrt 0 abr-ubr
```

The following example shows the ABR mode configuration with FC-PFQ installed:

```
Switch> show atm resource
Resource configuration:
    Over-subscription-factor 8  Sustained-cell-rate-margin-factor 1%
➔   Abr-mode:   efci
    Service Category to Threshold Group mapping:
     cbr 1 vbr-rt 2 vbr-nrt 3 abr 4 ubr 5
    Threshold Groups:
    Group Max    Max Q  Min Q  Q thresholds  Cell  Name
```

```
      cells  limit  limit  Mark Discard  count
      instal instal instal
---------------------------------------------------
 1    65535  63     63     25 %  87 %      0     cbr-default-tg
 2    65535  127    127    25 %  87 %      0     vbrrt-default-tg
 3    65535  511    31     25 %  87 %      0     vbrnrt-default-tg
 4    65535  511    31     25 %  87 %      0     abr-default-tg
 5    65535  511    31     25 %  87 %      0     ubr-default-tg
 6    65535  1023   1023   25 %  87 %      0     well-known-vc-tg
```

Configuring the Connection Traffic Table

A row in the connection traffic table (CTT) must be created for each unique combination of traffic parameters. Virtual path links (VPLs) and virtual channel links (VCLs) then specify traffic by specifying a row in the table per flow (receive and transmit). Many VCL/VPLs can refer to the same row in the traffic table.

The following two subsections outline the differences in the CTT feature according to platform and feature card.

CTT Supported Features (Catalyst 8540 MSR)

The rows corresponding to various service categories support the following features on the Catalyst 8540 MSR.

- Non-zero minimum cell rate (MCR) for UBR+ service categories. UBR+ is a variant of UBR, in which peak cell rate (PCR), MCR, and cell delay variation tolerance (CDVT) are specified in the traffic contract, with a guarantee on MCR.
- Both CDVT and maximum burst size (MBS) for VBR rows. Dual-leaky-bucket UPC is allowed.
- Whether SCR applies to either the CLP0 or CLP0+1 flow of cells. Only one or the other of these flows can be policed.

CTT Supported Features (Catalyst 8510 MSR and LightStream 1010)

ATM switch routers with feature card per-flow queuing (FC-PFQ) and software version 11.2(8) or later have more rows of various service categories that allow you to specify the following features:

- Non-zero minimum cell rate (MCR) for ABR and UBR+ service categories. UBR+ is a variant of UBR, in which peak cell rate (PCR), MCR, and cell delay variation tolerance (CDVT) are specified in the traffic contract, with a guarantee on MCR.
- Both CDVT and maximum burst size (MBS) for VBR rows. FC-PFQ allows dual-leaky-bucket UPC.
- Whether SCR applies to either the CLP0 or CLP0+1 flow of cells. FC-PFQ can police one or the other of these flows.

If your switch has FC-PCQ installed on the route processor you cannot take advantage of these new capabilities. CTT rows specifying these new parameters can be configured with FC-PCQ installed, with the following effect:

- Non-zero MCR is not supported. Requests for connections specifying non-zero MCR are rejected.
- On VBR connections, only SCR and MBS are used for UPC, and policing is done only on the CLP0+1 flow of cells.

PVC Connection Traffic Rows

The CTT in a permanent virtual channel (PVC) setup requires storing PVC traffic values in a CTT data structure. Rows used for PVCs are called stable rows, and contain traffic parameters.

SVC Connection Traffic Rows

The CTT in a switched virtual channel (SVC) setup provides a row identifier that Simple Network Management Protocol (SNMP) or the user interface can use to read or display SVC traffic parameters. A CTT row index is stored in the connection-leg data structure for each flow of the connection.

Note Rows cannot be deleted while in use by a connection.

CTT Row Allocations and Defaults

To make CTT management software more efficient, the CTT row-index space is split into rows allocated as a result of signalling and rows allocated from the command-line interface (CLI) and SNMP. Table 9-5 describes the row-index range for both.

Table 9-5 CTT Row-Index Allocation

Allocated by	Row-index range
ATOMMIB Traffic Descriptor Table or CLI connection-traffic-table-row creation	1 through 1,073,741,823
Signalling VxL creation	1,073,741,824 through 2,147,483,647

Table 9-6 describes the well-known, predefined ATM CTT rows.

Table 9-6 Default ATM Connection Traffic Table Rows

CTT Row Index	Service Category	Peak-Cell-Rate (clp01)	Sustained-Cell-Rate (clp01)	Tolerance	Use
1	UBR	7,113,539	—	None	Default PVP/PVC row index
2	CBR	424 kbps	—	None	CBR tunnel well-known (WK) VCs
3	VBR-RT	424 kbps	424 kbps	50	Physical interface/VBR-RT WK VCs
4	VBR-NRT	424 kbps	424 kbps	50	VBR-NRT tunnel WK VCs
5	ABR	424 kbps	—	None	—
6	UBR	424 kbps	—	None	UBR tunnel WK VCs

The **atm connection-traffic-table-row** command supports these service categories: CBR, VBR-RT, VBR-NRT, ABR, and UBR. To create or delete an ATM CTT row, perform the following tasks in global configuration mode:

Note Your CTT feature set depends on the type of feature card that is installed on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers route processor.

	Command	Purpose
Step 1	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] {**vbr-rt** | **vbr-nrt**} **pcr** *pcr-value* {**scr0** | **scr10**} *scr-value* [**mbs** *mbs-value*] [**cdvt** *cdvt_value*]	Configures an ATM CTT VBR row.
Step 2	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **cbr pcr** *pcr-value* [**cdvt** *cdvt-value*]	Configures an ATM CTT CBR row.
Step 3	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **abr pcr** *pcr-value* [**mcr** *mcr-value*] [**cdvt** *cdvt-value*]	Configures an ATM CTT ABR row.
Step 4	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **ubr pcr** *pcr-value* [**mcr** *mcr-value*] [**cdvt** *cdvt-value*]	Configures an ATM CTT UBR row.

If you do not specify an index row number, the system software determines if one is free and displays it in the allocated index field if the command is successful.

Example

The following example shows how to configure an ATM CTT row with an ABR peak cell rate of 30,000 kbps:

```
Switch(config)# atm connection-traffic-table-row abr pcr 30000
 Allocated index = 63999
```

Displaying the ATM Connection Traffic Table

To display the CTT configuration, use the following EXEC command:

Command	Purpose
show atm connection-traffic-table [**row** *row-index* | **from-row** *row-index*]	Displays the CTT configuration.

Example

The following example shows how to display the CTT configuration table:

```
Switch> show atm connection-traffic-table
Row      Service-category    pcr         scr/mcr       mbs          cdvt
1            ubr          7113539        none                       none
```

```
2            cbr            424                                  none
3            vbr-rt         424       424         50             none
4            vbr-nrt        424       424         50             none
5            abr            424         0                        none
6            ubr            424      none                        none
64000        cbr           1741                                  none
2147483645*  ubr              0      none                        none
2147483646*  ubr              1      none                        none
2147483647*  ubr        7113539      none                        none
```

Configuring the Sustainable Cell Rate Margin Factor

The sustained cell rate margin factor determines the aggressiveness of weighting sustainable cell rate (SCR) compared to peak cell rate (PCR). It uses the connection admission control algorithm in admitting VBR connections.

To configure the SCR for your ATM switch router, use the following global configuration command:

Command	Purpose
atm sustained-cell-rate-margin-factor *s-value*	Configures the sustained cell rate margin factor.

Note The **atm sustained-cell-rate-margin-factor** command affects subsequent connections but not connections that are already established.

Example

The following example shows how to configure the SCR margin factor as 85 percent of maximum:

```
Switch(config)# atm sustained-cell-rate-margin-factor 85
```

Displaying the SCR Margin Configuration

To display the SCR margin factor configuration, use the following EXEC command:

Command	Purpose
show atm resource	Displays the SCR margin factor configuration.

Example

The following example shows the SCR margin factor configuration:

```
Switch> show atm resource
Resource configuration:
➔ Sustained-cell-rate-margin-factor 85%
    Abr-mode:   EFCI
    Service Category to Threshold Group mapping:
     cbr 1 vbr-rt 2 vbr-nrt 3 abr 4 ubr 5
    Threshold Groups:
 Module   Group Max    Max Q  Min Q  Q thresholds  Cell  Name
  ID            cells  limit  limit  Mark Discard  count
```

```
               instal instal instal
 ------------------------------------------------------------
 1         1     131071  63      63      25 %  87 %      0     cbr-default-tg
           2     131071  127     127     25 %  87 %      0     vbrrt-default-tg
           3     131071  511     31      25 %  87 %      0     vbrnrt-default-tg
           4     131071  511     31      25 %  87 %      0     abr-default-tg
           5     131071  511     31      25 %  87 %      0     ubr-default-tg
           6     131071  1023    1023    25 %  87 %      0     well-known-vc-tg
============================================================
 2         1     131071  63      63      25 %  87 %      0     cbr-default-tg
           2     131071  127     127     25 %  87 %      0     vbrrt-default-tg
           3     131071  511     31      25 %  87 %      0     vbrnrt-default-tg
           4     131071  511     31      25 %  50 %      0     abr-default-tg
           5     131071  511     31      25 %  87 %      0     ubr-default-tg
           6     131071  1023    1023    25 %  87 %      0     well-known-vc-tg
============================================================
 7         1     131071  63      63      25 %  87 %      0     cbr-default-tg
           2     131071  127     127     25 %  87 %      0     vbrrt-default-tg
           3     131071  511     31      25 %  87 %      0     vbrnrt-default-tg
           4     131071  511     31      25 %  87 %      0     abr-default-tg
           5     131071  511     31      25 %  87 %      0     ubr-default-tg
           6     131071  1023    1023    25 %  87 %      0     well-known-vc-tg
============================================================
 8         1     131071  63      63      25 %  87 %      0     cbr-default-tg
           2     131071  127     127     25 %  87 %      0     vbrrt-default-tg
           3     131071  511     31      25 %  87 %      0     vbrnrt-default-tg
           4     131071  511     31      25 %  87 %      0     abr-default-tg
           5     131071  511     31      25 %  87 %      0     ubr-default-tg
           6     131071  1023    1023    25 %  87 %      0     well-known-vc-tg
============================================================
```

Overview of Threshold Groups

Threshold groups combine VCs/VPs to determine per-connection thresholds, based on the use of memory by the group.

Note Threshold groups are supported on the Catalyst 8540 MSR, and on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers equipped with the FC-PFQ feature card.

The initial default configuration of per-VC queueing on the switch has all connections of a service category assigned to one threshold group. However, the assignment of service categories to threshold groups is configurable. A service category cannot be mapped to more than one threshold group. If you configure a service category to a threshold group more than once, the last configuration stays in effect. The default assigns each service category to a different threshold group. However, you can assign more than one service category to a threshold group.

Note The configuration of threshold groups is static, not dynamic.

For a description of how the threshold group feature works, refer to the *Guide to ATM Technology*.

Table 9-7 lists the configuration parameter defaults.

Table 9-7 Threshold Group Configuration Parameter Defaults

Group	Maximum Cells[1]	Maximum Queue Limit[2]	Minimum Queue Limit[3]	Mark Threshold[4]	Discard Threshold[5]	Use
1	65,535	63	63	25%	87%	CBR
2	65,535	127	127	25%	87%	VBR-RT
3	65,535	511	31	25%	87%	VBR-NRT
4	65,535	511	31	25%	87%	ABR
5	65,535	511	31	25%	87%	UBR
6	65,535	1023	1023	25%	87%	well-known VCs

1. Maximum number of cells in threshold group
2. Maximum (uncongested) per-VC queue limit in cells
3. Minimum (congested) per-VC queue limit in cells
4. Marking threshold percent full of per-VC queue
5. Discard threshold percent full of per-VC queue

Configuring the Threshold Group

To configure the threshold groups on a ATM switch router, perform the following tasks in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm threshold-group service** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr**} *group*	Assigns a service category to a threshold group.
Step 2	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **max-cells** *number*	Configures the maximum number of cells queued for all connections that are members of the threshold group.
Step 3	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **discard-threshold** *percent*	Configures the threshold of per-connection queue-full at which the queue is considered full for CLP[2] discard and EPD[3].
Step 4	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **max-queue-limit** *number*	Configures the largest per-VC queue limit that is applied to connections in the threshold group.
Step 5	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **min-queue-limit** *number*	Configures the smallest per-VC queue-limit that is applied to connections in the threshold group.
Step 6	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **name** *name*	Configures the name associated with a threshold group.

	Command	Purpose
Step 7	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **max-cells** *number*	Configures the maximum number of cells queued for specified threshold group for all module-ids.[4] Optionally, configure for the specified threshold group for the specified module-id.
Step 8	Switch(config)# **atm threshold-group** [**module-id** *module*][1] *group* **marking-threshold** *percent*	Configures the threshold of per-connection queue-full at which the queue is considered full for EFCI marking and ABR relative-rate marking.

1. The **module-id** identifier is only supported on the Catalyst 8540 MSR.
2. CLP = cell loss priority.
3. EPD = early packet discard.
4. Each module on the Catalyst 8540 MSR has its own cell memory and threshold groups. There are eight of these modules in a 20-gigabyte configuration. Each module has a 64-kbps cell memory, and the threshold groups can be configured per module. By default, all the threshold groups of all the modules are configured identically.

Example

The following example shows how to configure ATM threshold group 5 with a maximum number of cells before the cells are discarded:

```
Switch(config)# atm threshold-group 5 max-cells 50000
```

Displaying the Threshold Group Configuration

To display the threshold group configuration, use the following user EXEC command:

Command	Purpose
show atm resource	Displays the threshold group configuration.

Example

The following example displays the threshold group configuration:

```
Switch> show atm resource
Resource configuration:
Sustained-cell-rate-margin-factor 1%
    Abr-mode:   EFCI
    Service Category to Threshold Group mapping:
     cbr 1 vbr-rt 2 vbr-nrt 3 abr 4 ubr 5
➔   Threshold Groups:
 Module   Group Max    Max Q  Min Q  Q thresholds  Cell  Name
  ID            cells  limit  limit  Mark Discard  count
                instal instal instal
 ------------------------------------------------------------
  1        1    131071  63     63     25 %  87 %      0     cbr-default-tg
           2    131071  127    127    25 %  87 %      0     vbrrt-default-tg
           3    131071  511    31     25 %  87 %      0     vbrnrt-default-tg
           4    131071  511    31     25 %  87 %      0     abr-default-tg
           5    131071  511    31     25 %  87 %      0     ubr-default-tg
           6    131071  1023   1023   25 %  87 %      0     well-known-vc-tg
===========================================================
  2        1    131071  63     63     25 %  87 %      0     cbr-default-tg
           2    131071  127    127    25 %  87 %      0     vbrrt-default-tg
           3    131071  511    31     25 %  87 %      0     vbrnrt-default-tg
           4    131071  511    31     25 %  50 %      0     abr-default-tg
```

```
        5    131071   511     31      25 %   87 %       0     ubr-default-tg
        6    131071   1023    1023    25 %   87 %       0     well-known-vc-tg
===========================================================
<information deleted>
```

Configuring Physical Interfaces

Physical interface resource management configurations affect only specific interfaces on the switch. The following sections describe physical interface configuration resource management tasks:

- "Configuring the Interface Maximum Queue Size (Catalyst 8510 MSR and LightStream 1010)" section on page 9-17
- "Configuring the Interface Queue Thresholds per Service Category (Catalyst 8510 MSR and LightStream 1010)" section on page 9-19
- "Configuring Interface Output Pacing" section on page 9-21
- "Configuring Controlled Link Sharing" section on page 9-22
- "Configuring the Scheduler and Service Class" section on page 9-24

Configuring the Interface Maximum Queue Size (Catalyst 8510 MSR and LightStream 1010)

Maximum queue size feature on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers is used to determine the following:

- Maximum number of cells in the switch fabric queue
- Maximum cell transfer delay (CTD)
- Peak-to-peak cell delay variation (CDV) provided on an output switch interface

Note Interface maximum queue size configuration is only possible on switches with FC-PCQ installed on your route processor.

Because not all queue size values are supported by the switch fabric, the value installed is displayed, as well as the configuration value requested. The value installed is always greater than or equal to that requested.

To configure the maximum queue size, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm output-queue** [**force**] {**cbr** | **vbr-rt** | **vbr-nrt** | **abr-ubr**} **max-size** *number*	Configures the ATM output queue maximum size.

Note The **atm output-queue** command affects all connections, including those already established.

This command is not applicable for subinterface level configuration. For other restrictions, refer to the *ATM Switch Router Command Reference* publication.

If the interface status is up, the **force** parameter is required before the request is completed. If the request is forced, output on the interface is briefly disabled, cells on the output queue are discarded, and the queue size is changed to the new limit. Any impact on existing connections by the implicit change in guaranteed maximum CTD and peak-to-peak CDV is not considered before making the change. Subsequent setup of switched virtual channel (SVC) connections will be affected.

Note The queue must be momentarily disabled to change the threshold.

Example

The following example shows how to configure the CBR ATM output queue maximum size to 30,000 cells:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm output-queue force cbr max-size 30000
```

Displaying the Output Queue Maximum Configuration (Catalyst 8510 MSR and LightStream 1010)

To display the output queue maximum size configuration, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card/subcard/port*	Displays the output queue maximum size configuration.

Example

The following example displays the interface output queue maximum size configuration with FC-PCQ installed:

```
Switch> show atm interface resource atm 3/0/0
Resource Management configuration:
    Output queues:
➔       Max sizes(explicit cfg): 30000  cbr, none vbr-rt, none vbr-nrt, none abr-ubr
        Max sizes(installed): 30208 cbr, 256 vbr-rt, 4096 vbr-nrt, 12032 abr-ubr
        Efci threshold: 25% cbr, 25% vbr-rt, 25% vbr-nrt, 25% abr, 25% ubr
        Discard threshold: 87% cbr, 87% vbr-rt, 87% vbr-nrt, 87% abr, 87% ubr
        Abr-relative-rate threshold: 25% abr
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
```

```
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
        CDVT TX: none cbr, none vbr, none abr, none ubr
        MBS: none vbr RX, none vbr TX
Resource Management state:
    Cell-counts: 0 cbr, 0 vbr-rt, 0 vbr-nrt, 0 abr-ubr
    Available bit rates (in Kbps):
        147743 cbr RX, 147743 cbr TX, 147743 vbr RX, 147743 vbr TX,
        0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
    Allocated bit rates:
        0 cbr RX, 0 cbr TX, 0 vbr RX, 0 vbr TX,
        0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
    Best effort connections: 1 pvcs,  0 svcs
```

Configuring the Interface Queue Thresholds per Service Category (Catalyst 8510 MSR and LightStream 1010)

The queue thresholds can be specified for the different levels of service and configured on each interface queue. The following queue thresholds can be configured:

- Output queue EFCI threshold
- Output queue cell loss priority (CLP) and packet discard (PD) threshold
- ABR relative rate threshold

Note Interface queue threshold per-service category configuration is only possible on switches with FC-PCQ installed on your route processor.

These queue thresholds can be changed at any time. The result changes the threshold for all connections of that service category using the interface for output and for any subsequent connections.

Note The CLP and PD discard threshold and ABR relative rate threshold have finer granularity than the explicit forward congestion indication (EFCI) threshold.

To configure the output threshold, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm output-threshold** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr**} **discard-threshold** *disc-thresh-num*	Configures the ATM output discard threshold.
Step 3	Switch(config-if)# **atm output-threshold** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr**} **efci-threshold** *efci-thresh-number*	Configures the ATM output threshold.
Step 4	Switch(config-if)# **atm output-threshold abr relative-rate** *abr-thresh-number*	Configures the ATM output threshold ABR.

Note These commands affect all connections, including those already established.

These commands are not applicable for subinterface level configurations. For other restrictions, refer to the *ATM Switch Router Command Reference* publication.

Examples

The following example shows how to configure the interface output threshold CBR discard threshold to 87 percent of maximum size:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm output-threshold cbr discard 87
```

The following example shows how to configure the interface output discard threshold for CBR EFCI threshold to 50 percent of maximum size:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm output-threshold cbr efci 50
```

Displaying the Output Threshold Maximum Configuration (Catalyst 8510 MSR and LightStream 1010)

To display the output threshold maximum size configuration, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card/subcard/port*	Displays the output threshold maximum size configuration.

Example

The following example shows the interface output threshold maximum size configuration with FC-PCQ installed:

```
Switch> show atm interface resource atm 3/0/0
Resource Management configuration:
    Output queues:
        Max sizes(explicit cfg): 30000  cbr, none vbr-rt, none vbr-nrt, none abr-ubr
        Max sizes(installed): 30208 cbr, 256 vbr-rt, 4096 vbr-nrt, 12032 abr-ubr
➔       Efci threshold: 50% cbr, 25% vbr-rt, 25% vbr-nrt, 25% abr, 25% ubr
        Discard threshold: 87% cbr, 87% vbr-rt, 87% vbr-nrt, 87% abr, 87% ubr
        Abr-relative-rate threshold: 25% abr
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
```

```
        CDVT TX: none cbr, none vbr, none abr, none ubr
        MBS: none vbr RX, none vbr TX
<information deleted>
```

Configuring Interface Output Pacing

Output pacing is used to artificially reduce the output speed of an interface in kbps. Output pacing can be changed at any time, enabled, or disabled. When an output pacing change request is made, resource management determines if the change will not provide the guaranteed bandwidth at the outbound port for the existing virtual channels or virtual paths (VCs or VPs). Guaranteed bandwidth is reserved for constant bit rate (CBR) and variable bit rate (VBR) connections.

Note Pacing is only allowed for carrier module ports on the Catalyst 8540 MSR.

To enable or change an interface output pacing rate, perform the following tasks, beginning in global configuration mode:

Command	Purpose
interface atm *card/subcard/port*	Selects the interface to be configured.
atm pacing *kbps* [**force**]	Configures the interface output pacing.

The **force** argument indicates that the change should be made even if it results in an output cell rate that does not provide sufficient bandwidth for guaranteed service on the interface transmit flow. The **force** argument has no effect on Catalyst 8510 MSR and LightStream 1010 ATM switch routers with FC-PFQ installed on the route processor.

Note The **atm pacing** command affects all connections, including those already established.

This command does not apply to the CPU interfaces (atm0 and ethernet0) or subinterfaces. For other restrictions, refer to the *ATM Switch Router Command Reference* publication.

Note Since the 12.0(1a)W5(5b) release of the system software, addressing the interface on the route processor (CPU) has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. Old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

Example

The following example shows how to configure the interface output pacing to 10,000 kbps:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm pacing 10000
```

Displaying the Output Pacing Configuration

To display the output pacing configuration, use the following EXEC command:

Command	Purpose
show atm interface resource atm *card/subcard/port*	Displays the output pacing configuration.

Example

The following example shows the interface output pacing configuration:

```
Switch> show atm interface resource atm 0/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
➔   Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX,
        Tolerance RX: none cbr, none vbr, none abr, none ubr
        Tolerance TX: none cbr, none vbr, none abr, none ubr
<information deleted>
```

Configuring Controlled Link Sharing

Resource management allows fine-tuning of the connection admission control functions on a per-interface and direction (receive and transmit) basis. The reservations are specified with the following three parameters:

- Maximum aggregate guaranteed cell rate on an interface, which limits the guaranteed bandwidth that can be allocated on an interface
- Maximum guaranteed cell rates on an interface per-service category
- Minimum guaranteed cell rates on an interface per-service category

Table 9-8 shows the minimum and maximum parameter relationships.

Table 9-8 Connection Admission Control Parameter to Bandwidth Relationships

Service Category	Value	Service Category	Bandwidth
Minimum CBR	+	Minimum VBR	<= 95 percent
Minimum CBR	<=	Maximum CBR	<= 95 percent
Minimum VBR	<=	Maximum VBR	<= 95 percent
Minimum CBR	<=	Maximum Aggregate	<= 95 percent

Table 9-8 Connection Admission Control Parameter to Bandwidth Relationships (continued)

Service Category	Value	Service Category	Bandwidth
Minimum VBR	<=	Maximum Aggregate	<= 95 percent
Maximum CBR	<=	Maximum Aggregate	<= 95 percent
Maximum VBR	<=	Maximum Aggregate	<= 95 percent

To configure controlled link sharing, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm cac link-sharing max-guaranteed-service-bandwidth** {**receive** | **transmit**} *percent*	Configures controlled link sharing for the maximum guaranteed service bandwidth.
Step 3	Switch(config-if)# **atm cac link-sharing max-bandwidth** {**abr** | **cbr** | **ubr** | **vbr**} {**receive** | **transmit**} *percent*	Configures controlled link sharing for the maximum guaranteed service bandwidth by service category.
Step 4	Switch(config-if)# **atm cac link-sharing min-bandwidth** {**cbr** | **vbr** | **abr** | **ubr**} {**receive** | **transmit**} *percent*	Configures controlled link sharing for the minimum guaranteed service bandwidth by service category.

Note These commands affect subsequent connections but not connections that are already established.

For restrictions to these commands, refer to the *ATM Switch Router Command Reference* publication.

Example

The following example shows how to configure the controlled link sharing, maximum guaranteed service bandwidth, and receive configuration to 87 percent:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac link-sharing max-guaranteed-service-bandwidth receive 87
```

Displaying the Controlled Link Sharing Configuration

To display the controlled link sharing configuration, perform the following task in user EXEC mode:

Command	Purpose
show atm interface resource atm *card***/***subcard***/***port*	Displays the controlled link sharing configuration.

Example

The following example displays the controlled link sharing configuration:

```
Switch> show atm interface resource atm 0/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Link Distance: 0 kilometers
➔   Controlled Link sharing:
➔       Max aggregate guaranteed services: none RX,  none TX
➔       Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
➔       Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX,
        Tolerance RX: none cbr, none vbr, none abr, none ubr
        Tolerance TX: none cbr, none vbr, none abr, none ubr
<information deleted>
```

Configuring the Scheduler and Service Class

A service class denotes one of the scheduling classes referred to as output virtual circuit (OVC) QoS classes. Up to eight service classes can be allocated to each physical interface (PIF) port. In scheduling the next cell to be transmitted from a port, the rate scheduler (RS) has first call on supplying an eligible cell. If RS does not have one, then weighted round-robin (WRR) scheduler chooses a service class with an OVC ready to transmit, and finally a VC within the service class is selected.

Note Scheduler and service class configuration is only possible on Catalyst 8510 MSR and LightStream 1010 ATM switch routers with FC-PFQ installed on your route processor.

ATM service categories are mapped statically to service classes, as shown in Table 9-9, where service class 2 has the highest scheduling priority.

Table 9-9 ATM Service Category to Service Class

Service Category	Service Class
VBR-RT	2
VBR-NRT	3
ABR	4
UBR	5

Each service class is assigned a weight. These weights are configurable, in the range of 1 to 15. The default weighting is {15,2,2,2} for classes {2,3,4,5}, respectively. The weighting is not modified dynamically.

Within service classes, individual PVCs are also weighted, again in the range of 1 to 15. A standard weight (2) is assigned to all PVCs in a service class. Optionally, PVCs can be configured with a specific weight per half-leg (applying to the transmit OVC weight). SVCs take the value 2.

Note For a detailed description of rate and WRR scheduling, refer to the *Guide to ATM Technology*.

To configure the interface service class and WRR value, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm service-class** {**2** | **3** | **4** | **5**} **wrr-weight** *weight*	Configures the weight given to each service class.

Example

The following example shows how to configure service class 3 on interface ATM 0/1/0 with a WRR weight of 5:

```
Switch(config)# interface atm 0/1/0
Switch(config-if)# atm service-class 3 wrr-weight 5
```

Displaying the Interface Service Class Information

To display the configuration of an interface in a service class, use the following user EXEC command:

Command	Purpose
show atm interface resource {**atm** | **atm-p**} *card***/***subcard***/***port*	Displays the configured membership of the interface in a service class.

Example

The following example shows the configuration of the interface in a service class:

```
Switch> show atm interface resource atm 0/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX,
        Tolerance RX: none cbr, none vbr, none abr, none ubr
        Tolerance TX: none cbr, none vbr, none abr, none ubr
<information deleted>
```

Configuring Physical and Logical Interface Parameters

The following sections describe interface configuration resource management tasks for both physical and logical interface types:

- Configuring the Interface Link Distance, page 9-26
- Configuring the Limits of Best-Effort Connections, page 9-27
- Configuring the Interface Maximum of Individual Traffic Parameters, page 9-29
- Configuring the ATM Default CDVT and MBS, page 9-31
- Configuring Interface Service Category Support, page 9-33
- Configuring SVC Policing by Service Category, page 9-35

Configuring the Interface Link Distance

Specifying the physical link distance for the next ATM hop in the outbound direction allows you to increase the propagation delay. Propagation delay is used in determining the connection admission control (CAC) maximum cell transfer delay (CTD) provided on the output by a switch interface, which can affect the switched virtual channel (SVC) connection requests accepted.

Note For a detailed description of the CAC algorithm pseudo-code on the ATM switch router, refer to the *Guide to ATM Technology*.

To configure the interface link distance, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm link-distance** *kilometers*	Configures the interface link distance for the interface.

Note The **atm link-distance** command affects subsequent connections but not connections that are already established.

Example

The following example shows how to configure the outbound link distance to 150 kilometers:

```
Switch(config-if)# atm link-distance 150
```

Displaying the Interface Link Distance Configuration

To display the interface link distance configuration, use the following EXEC command:

Command	Purpose
show atm interface resource atm *card***/***subcard***/***port*[**.***vpt#*]	Displays the interface link distance configuration.

Example

The following example shows the configuration of the interface link distance with switch processor feature card installed:

```
Switch> show atm interface resource atm 0/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
➔   Link Distance: 150 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
        CDVT TX: none cbr, none vbr, none abr, none ubr
        MBS: none vbr RX, none vbr TX
<information deleted>
```

Configuring the Limits of Best-Effort Connections

Each interface can be configured to allow a specific number of best-effort available bit rate (ABR) and unspecified bit rate (UBR) connections.

To configure the number of best-effort connections, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm cac best-effort-limit** *conn-value*	Configures the connection best-effort limit.

Note These commands affect subsequent connections but not connections that are already established.

Example

The following example shows how to configure the connection best-effort limit configuration to 2000:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac best-effort-limit 2000
```

Displaying the Interface Best-Effort Limit Configuration

To display the interface best-effort configuration, use the following EXEC command:

Command	Purpose
show atm interface resource atm *card*/*subcard*/*port*[.*vpt#*]	Displays the subinterface best-effort configuration.

Example

The following example shows the interface best-effort configuration with the switch processor feature card installed:

```
Switch> show atm interface resource atm 3/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
➔   Best effort connection limit: enabled  2000 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
        CDVT TX: none cbr, none vbr, none abr, none ubr
        MBS: none vbr RX, none vbr TX
<information deleted>
```

Configuring the Interface Maximum of Individual Traffic Parameters

When a VCC is set up, you can specify per-flow (receive and transmit traffic) parameters. Traffic parameter limits may be configured independently by service category and traffic direction for the following:

- Maximum peak cell rate (PCR)
- Maximum sustained cell rate (SCR)
- Maximum cell delay variation tolerance (CDVT)
- Maximum burst size (MBS)
- Maximum minimum cell rate (MCR)

To configure the traffic parameters, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm cac max-peak-cell-rate** {**cbr** | **vbr** | **abr** | **ubr**} {**receive** | **transmit**} *rate*	Configures the connection maximum PCR.
Step 3	Switch(config-if)# **atm cac max-sustained-cell-rate** {**receive** | **transmit**} *rate*	Configures the connection SCR.
Step 4	Switch(config-if)# **atm cac max-cdvt** {**abr** | **cbr** | **ubr** | **vbr**} {**receive** | **transmit**} *cell-count*	Configures the connection maximum CDVT.
Step 5	Switch(config-if)# **atm cac max-mbs** {**receive** | **transmit**} *cell-count*	Configures the connection maximum MBS.
Step 6	Switch(config-if)# **atm cac max-min-cell-rate** {**abr** | **ubr**} {**receive** | **transmit**} *rate*	Configures the connection maximum MCR per service category flow.

Note These commands affect subsequent connections but not connections that are already established.

Examples

The following example shows how to configure the maximum PCR for constant bit rate (CBR) connections on interface 3/0/0, specified in receive mode, to 100,000 kbps:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac max-peak-cell-rate cbr receive 100000
```

The following example shows how to configure the maximum SCR for connections on interface 3/0/0, specified in receive mode, to 60,000 kbps:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac max-sustained-cell-rate receive 60000
```

The following example shows how to configure the maximum tolerance for CBR connections on interface 3/0/0, specified in receive mode, 75,000 kbps:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac max-cdvt cbr receive 75000
```

Displaying the Interface Maximum Individual Traffic Parameter Configuration

To display the interface maximum individual traffic parameter configuration, use the following EXEC command:

Command	Purpose
show atm interface resource atm [*card***/***subcard***/***port*[**.***vpt#*]]	Displays the controlled link sharing configuration.

Example

The following example shows the interface maximum individual traffic configuration with switch processor feature card installed:

```
Switch> show atm interface resource atm 3/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: enabled  2000 max connections
➔   Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
        CDVT TX: none cbr, none vbr, none abr, none ubr
        MBS: none vbr RX, none vbr TX
<information deleted>
```

Configuring the ATM Default CDVT and MBS

You can change the default cell delay variation tolerance (CDVT) and maximum burst size (MBS) to request for UPC of cells received on the interface for connections that do not individually request a CDVT or MBS value.

You can specify CDVT or MBS for PVCs through a connection traffic table row. If no CDVT or MBS is specified in the row, then a per-interface, per-service category default is applied for purposes of usage parameter control (UPC) on the connection.

Note For signalled connections, CDVT or MBS cannot be signalled and the defaults specified on the interface apply.

To configure the default CDVT and MBS parameters, perform the following task, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enter interface configuration mode.
Step 2	Switch(config-if)# **atm cdvt-default** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr**} *number*	Configures the ATM CDVT default.
Step 3	Switch(config-if)# **atm mbs-default** {**vbr-rt** | **vbr-nrt**} *number*	Configures the ATM MBS default.

Example

The following example shows how to change the default tolerance for received cells on VBR-RT connections:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cdvt-default vbr-rt 4000
```

Displaying the ATM CDVT and MBS Configuration

To display the ATM CDVT and MBS configuration, use the following EXEC commands:

Command	Purpose
show atm vc	Displays the ATM VC CDVT configuration.
show atm vp	Displays the ATM VP CDVT configuration.

Examples

The following example shows the ATM CDVT and MBS configuration of an ATM VC:

```
Switch> show atm vc interface atm 0/0/3 0 100

Interface: ATM0/0/3, Type: oc3suni
VPI = 0  VCI = 100
Status: UP
Time-since-last-status-change: 00:00:08
Connection-type: PVC
```

```
Cast-type: point-to-point
Packet-discard-option: disabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/0/2, Type: oc3suni
Cross-connect-VPI = 0
Cross-connect-VCI = 100
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 2, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 9999
Rx service-category: VBR-RT (Realtime Variable Bit Rate)
Rx pcr-clp01: 40000
Rx scr-clp0 : 30000
Rx mcr-clp01: none
→ Rx      cdvt: 1024 (from default for interface)
→ Rx       mbs: 1024 (from default for interface)
Tx connection-traffic-table-index: 9999
Tx service-category: VBR-RT (Realtime Variable Bit Rate)
Tx pcr-clp01: 40000
Tx scr-clp0 : 30000
Tx mcr-clp01: none
→ Tx      cdvt: none
→ Tx       mbs: none
```

The following example shows the ATM CDVT and MBS configuration of an ATM VP:

```
Switch> show atm vp interface atm0/0/3 4

Interface: ATM0/0/3, Type: oc3suni
VPI = 4
Status: UP
Time-since-last-status-change: 00:00:10
Connection-type: PVP
Cast-type: point-to-point
Usage-Parameter-Control (UPC): pass
Wrr weight: 32
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/0/2, Type: oc3suni
Cross-connect-VPI = 4
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 5, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
Rx connection-traffic-table-index: 1
Rx service-category: UBR (Unspecified Bit Rate)
Rx pcr-clp01: 7113539
Rx scr-clp01: none
```

```
   Rx mcr-clp01: none
➔  Rx      cdvt: 1024 (from default for interface)
➔  Rx       mbs: none
   Tx connection-traffic-table-index: 1
   Tx service-category: UBR (Unspecified Bit Rate)
   Tx pcr-clp01: 7113539
   Tx scr-clp01: none
   Tx mcr-clp01: none
➔  Tx      cdvt: none
➔  Tx       mbs: none
```

Configuring Interface Service Category Support

You can configure which service categories connection admission control (CAC) allows on an interface. You can configure interface service category support only on physical interfaces and shaped and hierarchical logical virtual path (VP) tunnel interfaces.

Note For information on how to configure your physical and logical VP tunnel interfaces, see Chapter 7, "Configuring Virtual Connections."

The underlying service category for shaped and hierarchical VP tunnels is CBR. For VP shaped tunnels, interface service category support can be used to configure a service category other than CBR for VCs within the tunnel. For physical interfaces and hierarchical VP tunnels, all service category VCs (by default) can migrate across the interface. However, you can use the interface service category support feature to explicitly allow or prevent VCs of specified service categories to migrate across the interface.

Table 9-10 shows the service category of the shaped VP (always CBR), the service categories you can configure for transported VCs, and a suggested transit VP service category for the tunnel.

Table 9-10 Service Category Support for Physical and Logical Interfaces

Shaped VP Tunnel Service Category	VC Service Category	Suggested Transit VP Service Category
CBR	CBR	CBR
CBR	VBR	CBR or VBR
CBR	ABR[1]	CBR or VBR
CBR	UBR	Any service category

1. We recommend ABR only if the transit VP is set up so that congestion occurs at the shaped tunnel, not in the transit VP.

The following restrictions apply to interface service category support:

- This configuration is allowed on physical interfaces and shaped and hierarchical VP tunnel logical interfaces.
- On shaped VP tunnel logical interfaces, only one service category is permitted at a time. To replace CBR with another service category on these interfaces, you must first deny the CBR service category, then permit the chosen service category. To deny a service category, you must delete all user VCs of that service category on the interface.
- For ABR and UBR, only zero MCR is supported on VCs on a shaped VP tunnel.

To configure a service category on an interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface to be configured.
Step 2	**atm cac service-category** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr**} {**permit** | **deny**}	Configures the service category on the interface.

Example

The following example shows how to configure the ABR service category on ATM interface 3/0/0:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm cac service-category cbr deny
Switch(config-if)# atm cac service-category abr permit
```

Displaying the Service Category on an Interface

To display the service category configured on an interface, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card***/***subcard***/***port*[**.***vpt#*]	Displays the controlled link sharing configuration.

Example

The following example shows the service category configuration:

```
Switch> show atm interface resource atm 3/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c1 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 8 c2, 1 c3, 1 c4, 1 c5
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
➔     Service Categories supported: cbr,vbr-rt,vbr-nrt,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none abr, none ubr
        Minimum-cell-rate TX: none abr, none ubr
        CDVT RX: none cbr, none vbr, none abr, none ubr
        CDVT TX: none cbr, none vbr, none abr, none ubr
<information deleted>
```

Configuring SVC Policing by Service Category

You can configure policing on any ATM switch router interface to tag or drop cells in the forward (into the network) direction of a virtual connection. These traffic policing mechanisms are known as usage parameter control (UPC). With UPC, the ATM switch router determines whether received cells comply with the negotiated traffic management values and takes one of the following actions on violating cells:

- Pass the cell without changing the CLP (cell loss priority) bit in the cell header.
- Tag the cell with a CLP bit value of 1.
- Drop (discard) the cell.

The ATM policing by service category for the SVC and Soft PVC features enables you to specify which traffic to police, based on service category, switched virtual circuits (SVCs) or, terminating VCs on the destination end of a soft VC.

For more information on UPC, see the "Traffic and Resource Management" chapter in the *Guide to ATM Technology*.

This feature enables you to select which and how traffic is affected by UPC. For example, you can configure your switch to pass all UBR traffic, but tag all other traffic types.

Note For information on how to configure your physical and logical VP tunnel interfaces, see Chapter 7, "Configuring Virtual Connections."

To configure ATM policing by service category for the SVC and Soft PVC features, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm svc-upc-intent** [**abr** | **cbr** | **vbr-rt** | **vbr-nrt** | **ubr**] {**tag** | **pass** | **drop**} (Repeat this step for each service category and UPC mode combination.)	Specifies the UPC mode. If no service category is specified, then the UPC mode configuration is applied to all traffic types.

Example

The following example configures ATM interface 1/1/1 so any violating ABR service category traffic is dropped as it enters the interface:

```
Switch(config)# interface atm 1/1/1
Switch(config-if)# atm svc-upc-intent abr drop
```

In the following example, the UBR traffic on an interface is passed while all other traffic is policed:

```
Switch(config-if)# atm svc-upc-intent ubr pass
Switch(config-if)# atm svc-upc-intent cbr tag
Switch(config-if)# atm svc-upc-intent vbr-rt tag
Switch(config-if)# atm svc-upc-intent vbr-nrt tag
Switch(config-if)# atm svc-upc-intent abr drop
```

Displaying the Service Category Policing on an Interface

To display the service category policing configured on an interface, use the following user EXEC commands:

Command	Purpose
show atm interface atm *card/subcard/port*	Displays the service category policing configuration.
show run atm interface *card/subcard/port*	Displays the interface service category policing configuration.

Example

The following example shows service category policing configured on ATM interface 1/1/1:

```
Switch> show atm interface atm 1/1/1

Interface:      ATM1/1/1        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   completed
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: by sc           Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.00e0.f75d.0401.4000.0c80.9010.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      4        0       0       0       0        0       0          4          4
Logical ports(VP-tunnels):     0
Input cells:    4927            Output cells:   3553
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 2376, Output AAL5 pkts: 2382, AAL5 crc errors: 0

Switch>
```

In the **show atm interface atm** command display, if interface service category policing is configured, the SVC Upc Intent field displays “by sc” (service category).

The following example shows the service category policing configuration of interface ATM 1/1/1:

```
Switch# show running-config interface atm 1/1/1
Building configuration...

Current configuration : 223 bytes
!
interface ATM1/1/1
 no ip address
 no ip route-cache
 no ip mroute-cache
 no atm ilmi-keepalive
 atm svc-upc-intent cbr tag
 atm svc-upc-intent vbr-rt tag
 atm svc-upc-intent vbr-nrt tag
 atm svc-upc-intent abr drop
end
```

```
Switch#
```

In the previous example, ATM interface 1/1/1 is configured to allow any UBR traffic to passed while all other traffic is policed.

Configuring Interface Overbooking

The interface overbooking feature allows the available equivalent bandwidth of an interface to exceed the maximum cell rate (MaxCR) or physical line rate on ATM and inverse multiplexing over ATM (IMA) interfaces. The available equivalent bandwidth is by default limited by the MaxCR. Increasing the available equivalent bandwidth beyond the MaxCR allows the configuration of more connections on an interface than its physical bandwidth would allow. Overbooking allows more flexibility when configuring an interface when the traffic over the interface will be less than the MaxCR.

The following restrictions apply to interface overbooking:

- Regular VP tunnels do not support interface overbooking.
- You cannot add new hierarchical VP tunnels on a physical interface if the interface's bandwidth guarantees exceed the MaxCR regardless of any overbooking configured on that interface.
- On IMA interfaces, the available equivalent bandwidth for PVCs differs from the available equivalent bandwidth for SVCs. The available equivalent bandwidth for PVCs is based on the number of interfaces configured as part of the IMA group. The available equivalent bandwidth for SVCs on an IMA interface is based on the number of interfaces that are active in the IMA group. Overbooking increases both the available equivalent bandwidth values by the same configured percentage.
- The MaxCR for transmit and receive flows might differ on output-paced physical interfaces. Configuring overbooking on such interfaces results in different maximum guaranteed services bandwidth values and available cell rates for service categories for transmit and receive flows. Maximum guaranteed services bandwidth is the maximum equivalent bandwidth allocated for guaranteed services on the interface.
- When an interface is overbooked with traffic, cell flow through the well-known VCs might be reduced.
- Although overbooking increases the available cell rates for various service categories on an interface, various traffic parameters of a connection are still limited by the MaxCR.
- If the overbooking configuration results in a maximum guaranteed services bandwidth that is below the currently allocated bandwidth guarantees on an interface, the configuration is rejected.
- Per class overbooking configuration and interface overbooking configuration cannot co-exists on the same ATM and IMA interface. These two modes are mutually exclusive that are configurable on a per interface basis (on an ATM or IMA interface). See the section, Configuring Service Class Overbooking, page 9-39, for additional information.

Caution Overbooking can cause interface traffic to exceed the guaranteed bandwidth that the switch can provide.

Note Interface overbooking configuration is not supported on switches with feature card per-flow queuing (FC-PCQ) installed.

To configure interface overbooking, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	**interface atm** *card***/***subcard***/***slot* Switch(config-if)# or **interface atm** *card***/***subcard***/ima***group* Switch(config-if)#	Specifies the physical interface to configure. Specifies the IMA group interface to configure.
Step 2	Switch(config-if)# **shutdown**	Shuts down the interface prior to configuring overbooking.
Step 3	Switch(config-if)# **atm cac overbooking** *percent*	Configures overbooking on an interface as a percentage of the maximum equivalent bandwidth available on the interface from 100 to 1000. A value of 100 disables overbooking on the interface.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface

Example

The following example shows how to set the interface overbooking percentage to 300:

```
Switch(config)# interface atm 4/1/0
Switch(config-if)# shutdown
Switch(config-if)# atm cac overbooking 300
Switch(config-if)# no shutdown
```

Displaying the Interface Overbooking Configuration

To display the interface overbooking configuration, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card***/***subcard***/***port*[**.***vpt#*]	Displays the interface overbooking configuration.

Example

The following example shows the interface overbooking configuration with FC-PFQ installed:

```
Switch> show atm interface resource atm 4/1/0
Resource Management configuration:
    Service Classes:
        Service Category map: c2 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 15 c2, 2 c3, 2 c4, 2 c5
    CAC Configuration to account for Framing Overhead : Disabled
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
➔   overbooking :  300
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
```

```
            Max aggregate guaranteed services: none RX,  none TX
            Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                           none abr RX, none abr TX, none ubr RX, none ubr TX
            Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                           none abr RX, none abr TX, none ubr RX, none ubr TX
        Best effort connection limit: disabled  0 max connections
        Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
            Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
            Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
            Sustained-cell-rate: none vbr RX, none vbr TX
            Minimum-cell-rate RX: none abr, none ubr
            Minimum-cell-rate TX: none abr, none ubr
            CDVT RX: none cbr, none vbr, none abr, none ubr
            CDVT TX: none cbr, none vbr, none abr, none ubr
            MBS: none vbr RX, none vbr TX
    Resource Management state:
        Available bit rates (in Kbps):
            72959 cbr RX, 72959 cbr TX, 72959 vbr RX, 72959 vbr TX,
            72959 abr RX, 72959 abr TX, 72959 ubr RX, 72959 ubr TX
        Allocated bit rates:
            0 cbr RX, 0 cbr TX, 0 vbr RX, 0 vbr TX,
            0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
        Best effort connections: 0 pvcs,  0 svcs
```

Configuring Service Class Overbooking

The interface overbooking feature, described in the "Configuring Interface Overbooking" section on page 9-37, increases the overall equivalent bandwidth available for all service categories including CBR on an interface beyond the maximum cell rate that is possible on an interface.

The service class overbooking feature enables you to configure overbooking on an individual service category and per interface basis on ATM and IMA interfaces. The service categories VBR-rt, VBR-nrt, ABR and UBR+ can be overbooked.

Note Overbooking of the CBR service category is not allowed.

If a service category is configured with an overbooking percentage on an interface, the guaranteed bandwidth allocated (on the Rate Scheduler) for a VC belonging to that service category is scaled down to allow more VCs of that service category.

Service class overbooking configuration and interface overbooking configuration cannot co-exist on the same ATM and IMA interface. These two modes are mutually exclusive and are configurable on a per interface basis (on an ATM or IMA interface).

The following restrictions apply to service class overbooking:

- Service class overbooking is *not* supported on regular VP tunnels.
- If the overbooking configuration results in a maximum guaranteed services bandwidth that is below the currently allocated bandwidth guarantees on an interface, the configuration is rejected.
- When an interface is overbooked with traffic, cell flow through the well-known VCs might be reduced.
- Service Class overbooking configuration is *not* supported on switches with FC-PCQ (Feature Card Per-Class Queuing) installed.

To configure overbooking on an individual service class, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	**interface atm** *card***/***subcard***/***slot*[.*vpt#*] Switch(config-if)# or **interface atm** *card***/***subcard***/ima***group* Switch(config-if)#	Specifies the physical interface to configure. Specifies the IMA group interface to configure.
Step 2	Switch(config-if)# **shutdown**	Shuts down the interface prior to configuring overbooking.
Step 3	Switch(config-if)# **atm cac overbooking** {**abr** | **vbr-nrt** | **vbr-rt** | **ubr**} *percent*	Configures overbooking on the service class as a percentage of the maximum equivalent bandwidth available from 100 to 3200. A value of 100 disables service class overbooking on the interface.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to set the VBR-RT overbooking percentage to 200:

```
Switch(config)# interface atm 4/1/0
Switch(config-if)# shutdown
Switch(config-if)# atm cac overbooking vbr-rt 200
Switch(config-if)# no shutdown
```

Displaying the Interface Overbooking Configuration

To display the service class overbooking configuration, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card***/***subcard***/***port*[**.***vpt#*]	Displays the service class overbooking configuration.

Example

The following example shows the service class overbooking configuration for service classes VBR-RT and UBR to 200 percent:

```
Switch# show atm interface resource atm 1/1/0
Resource Management configuration:
    Service Classes:
        Service Category map: none cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 15 c2, 2 c3, 2 c4, 2 c5
    CAC Configuration to account for Framing Overhead : Disabled
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    overbooking :  disabled
    Per Class OverBooking :
```

```
→              vbr-rt : 200%,     vbr-nrt : disabled
→              abr : disabled,        ubr : 200%
        Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
        Link Distance: 0 kilometers
        Controlled Link sharing:
            Max aggregate guaranteed services: none RX,  none TX
            Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                           none abr RX, none abr TX, none ubr RX, none ubr TX
            Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                           none abr RX, none abr TX, none ubr RX, none ubr TX
        Best effort connection limit: disabled  0 max connections
        Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
            Peak-cell-rate RX: none cbr, none vbr, none abr, none ubr
            Peak-cell-rate TX: none cbr, none vbr, none abr, none ubr
            Sustained-cell-rate: none vbr RX, none vbr TX
            Minimum-cell-rate RX: none abr, none ubr
            Minimum-cell-rate TX: none abr, none ubr
            CDVT RX: none cbr, none vbr, none abr, none ubr
            CDVT TX: none cbr, none vbr, none abr, none ubr
            MBS: none vbr RX, none vbr TX
    Resource Management state:
        Available bit rates (in Kbps):
            147743 cbr RX, 147743 cbr TX, 147743 vbr RX, 147743 vbr TX,
            147743 abr RX, 147743 abr TX, 147743 ubr RX, 147743 ubr TX
        Allocated bit rates:
            0 cbr RX, 0 cbr TX, 0 vbr RX, 0 vbr TX,
            0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
        Best effort connections: 0 pvcs,  0 svcs
```

Configuring Framing Overhead

The interface framing overhead feature determines whether the MaxCR of a physical interface conforms to the actual physical line rate, including framing overhead. By default, the unframed rate is used for determining the MaxCR.

When framing overhead is considered, the MaxCR is less than the unframed rate and some previously configured connections might not be established. Table 9-11 provides the MaxCR values for the different framing modes, with and without framing overhead configured.

Table 9-11 MaxCR For Different Framing Overhead Configurations

Interface Type	Framing Mode	With Framing Overhead Configured	Without Framing Overhead Configured
OC-3	–	149,759 kbps	155,519 kbps
OC-12	–	599,032 kbps	622,079 kbps
OC-48c[1]	–	2,396,156 kbps	2,488,319 kbps
DS3	M23 ADM	44,209 kbps	44,735 kbps
	M23 PLCP	40,704 kbps	44,735 kbps
	CBIT ADM	44,209 kbps	44,735 kbps
	CBIT PLCP	40,704 kbps	44,735 kbps
E3	G 832 ADM	33,920 kbps	34,367 kbps
	G 751 ADM	34,009 kbps	34,367 kbps

Table 9-11 MaxCR For Different Framing Overhead Configurations (continued)

Interface Type	Framing Mode	With Framing Overhead Configured	Without Framing Overhead Configured
E1	G 751 PLCP	30,528 kbps	34,367 kbps
	CRC4 ADM	1919 kbps	2047 kbps
	CRC4 PLCP	1785 kbps	2047 kbps
	PCM30 ADM	1919 kbps	2047 kbps
	PCM30 PLCP	1785 kbps	2047 kbps
T1	SF ADM	1535 kbps	1543 kbps
	SF PLCP	1413 kbps	1543 kbps
	ESF ADM	1535 kbps	1543 kbps
	ESF PLCP	1413 kbps	1543 kbps

1. OC-48c is only available on the Catalyst 8540 MSR.

The framing mode changes when you issue the **framing** command on an interface and the MaxCR is adjusted accordingly. If enabling framing overhead reduces the maximum guaranteed service bandwidth supported on a direction of an interface below the current allocation, use the **force** option to ensure that the configuration takes effect.

To configure framing overhead, use the following interface configuration commands:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*slot* Switch(config-if)#	Specifies the physical interface to configure.
Step 2	Switch(config-if)# **atm cac framing overhead** [**force**]	Configures framing overhead on an interface

Example

The following example shows how to enable framing overhead on an interface:

```
Switch(config)# interface atm 4/1/0
Switch(config-if)# atm cac framing overhead
```

Displaying the Framing Overhead Configuration

To display the framing overhead configuration, use the following user EXEC command:

Command	Purpose
show atm interface resource atm *card*/*subcard*/*port*[**.***vpt#*]	Displays the interface framing overhead configuration.

Example

The following example shows the framing overhead configuration:

```
Switch> show atm interface resource atm 4/1/0
Resource Management configuration:
    Service Classes:
        Service Category map: c2 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 15 c2, 2 c3, 2 c4, 2 c5
➔   CAC Configuration to account for Framing Overhead : Enabled
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    overbooking :  disabled
    Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none abr RX, none abr TX, none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
<information deleted>
```

CHAPTER 10

Configuring ILMI

This chapter describes the Integrated Local Management Interface (ILMI) protocol implementation within the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For a description of the role of ILMI, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Configuring the Global ILMI System

This section describes configuring the ATM address and the LAN emulation configuration server (LECS) address, and displaying the ILMI configuration for the entire switch.

Configuring the ATM Address

The ATM switch router ships with an autoconfigured ATM address. Private Network-Network Interface (PNNI) uses the autoconfigured address to construct a flat PNNI topology. ILMI uses the first 13 bytes of this address as the switch prefix that it registers with end systems. For a description of the autoconfigured ATM address and considerations when assigning a new address, refer to the *Guide to ATM Technology.*

Note The most important rule in the addressing scheme is to maintain the uniqueness of the address across very large networks.

Multiple addresses can be configured for a single switch, and this configuration can be used during ATM address migration. ILMI registers end systems with multiple prefixes during this period until an old address is removed. PNNI automatically summarizes all of the switch's prefixes in its reachable address advertisement.

To configure a new ATM address that replaces the previous ATM address, see Chapter 11, "Configuring ATM Routing and PNNI."

Configuring Global ILMI Access Filters

The ILMI access filter feature allows you to permit or deny certain ILMI registered addresses.

Note If you want to allow certain addresses to be registered via ILMI, but restrict those addressees from being advertised through PNNI, use the PNNI suppressed summary address feature instead. For additional information, see the Chapter 11, "Configuring ATM Routing and PNNI," or the **summary-address** command in the *ATM Switch Router Command Reference* publication.

If end systems are allowed to register arbitrary addresses via ILMI, including addresses that do not match the ILMI prefixes used on the interface, a security hole may be opened. The ILMI access filter feature closes the security hole by permitting or denying ILMI registration of different classes of addresses.

The ILMI access filter allows you to configure two levels of access filters:

- Globally, to configure the switch default access filter
- At the interface level, to set the per-interface specific override

In either level, you can choose among the following options:

- Permit all—Any ATM end system address (AESA) registered by an attached end system is permitted.
- Permit prefix match—Only AESAs that match an ILMI prefix used on the interface are permitted.
- Permit prefix match and well-known group addresses—AESAs that match an ILMI prefix used on the interface as well as the well-known group addresses, including the old LECS address (47.0079.0000.0000.0000.0000.0000.00A0.3E00.0001.00) and any address matching the ATM Forum address prefix for well-known address (C5.0079.0000.0000.0000.0000.0000.00A0.3E) are permitted.
- Permit prefix match and all group addresses—All group addresses, including the well-known group addresses, as well as AESAs that match the ILMI prefix(es) used on the interface are permitted.

To configure global ILMI access filters, use the following global configuration command:

Command	Purpose
atm ilmi default-access permit {**all** | **matching-prefix** [**all-groups** | **wellknown-groups**]}	Configures an ILMI default access filter.

Note If you use Cisco's Simple Server Redundancy Protocol (SSRP) for LAN emulation in this network, ILMI registration of well-known group addresses should be permitted. This allows the active LECS to register the well-known LECS address with the switch. Either the **permit all**, **permit matching-prefix wellknown-groups**, or **permit matching-prefix all-groups** option should be configured.

Example

The following example configures the global default access filter for ILMI address registration to allow well-known group addresses and addresses with matching prefixes:

```
Switch(config)# atm ilmi default-access permit matching-prefix wellknown-groups
```

See the command **atm address-registration** in the *ATM Switch Router Command Reference* publication for information on configuration of the individual interface access filter override.

Display the ILMI Access Filter Configuration

To display the global ILMI default access configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the global ILMI default access configuration.

Example

The following example displays the ILMI filter configuration for all ATM interfaces:

```
Switch# more system:running-config
Building configuration...
Current configuration:

<information deleted>

!
atm abr-mode efci
atm lecs-address-default 47.0091.8100.0000.0040.0b0a.1281.0040.0b4e.d023.00 1
atm lecs-address-default 47.0091.8100.0000.0040.0b0a.1281.0040.0b07.4023.00 2
atm ilmi default-access permit matching-prefix
atm address 47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81.00
atm address 47.0091.8100.0000.0060.3e5a.7901.0060.3e5a.7901.00
atm router pnni
 statistics call
 node 1 level 56 lowest
```

Configuring the LANE Configuration Server Address

To configure the LECS address advertised to the directly connected end nodes, use the following global configuration command:

Command	Purpose
atm lecs-address *lecs-address* [*sequence-number*]	Configures the switch LECS address.

The *sequence-number* provides the position of this address in the ordered LECS address table.

Example

The following example shows how to configure the LECS ATM address:

```
Switch(config)# atm lecs-address 47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9030.01
```

Displaying the ILMI Global Configuration

To display the switch ILMI configuration, use the following EXEC commands:

Command	Purpose
show atm addresses	Displays the ATM addresses.
show atm ilmi-configuration	Displays the ILMI configuration.
show atm ilmi-status	Displays the ILMI status.

Examples

The following example shows the ATM address and the LECS address:

```
Switch# show atm addresses

Switch Address(es):
  47.00918100000000000CA79E01.00000CA79E01.00 active
  88.888888880000000000000000.000000005151.00

Soft VC Address(es):
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.0000.00 ATM0
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.8000.00 ATM3/0/0
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.8010.00 ATM3/0/1
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.8020.00 ATM3/0/2
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.8030.00 ATM3/0/3
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9000.00 ATM3/1/0
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9010.00 ATM3/1/1
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9020.00 ATM3/1/2
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9030.00 ATM3/1/3

ILMI Switch Prefix(es):
  47.0091.8100.0000.0000.0ca7.9e01
  88.8888.8888.0000.0000.0000.0000

ILMI Configured Interface Prefix(es):

LECS Address(es):
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9030.01
  47.0091.8100.0000.0000.0ca7.9e01.4000.0c81.9030.02
```

Note Since Cisco IOS Release12.0(1a)W5(5b) of the system software, addressing the interface on the route processor (CPU) has changed for Catalyst 8510 and LightStream 1010 platforms. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. Old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

The following example shows the ILMI configuration:

```
Switch# show atm ilmi-configuration

Switch ATM Address (s) :
1122334455667788990112233445566778899000
LECS Address (s):
1122334455667788990011223344556677889900
```

```
ARP Server Address (s):
11223344556677889900112233445566778899 00
```

The following example shows the ILMI status:

```
Switch# show atm ilmi-status

Interface : ATM0 Interface Type : Local
Configured Prefix(s) :
47.0091.8100.0000.0003.c386.b301

Interface : ATM3/0/0 Interface Type : Private NNI
ILMI VCC : (0, 16) ILMI Keepalive : Disabled
Configured Prefix(s) :
47.0091.8100.0000.0003.c386.b301

Interface : ATM3/0/3 Interface Type : Private NNI
ILMI VCC : (0, 16) ILMI Keepalive : Disabled
Configured Prefix(s) :
47.0091.8100.0000.0003.c386.b301
```

Configuring an ILMI Interface

To configure an ILMI interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm auto-configuration**	Enables ILMI autoconfiguration, including determination of interface protocol, version, and side.
Step 3	Switch(config-if)# **atm address-registration**	Configures ILMI address registration for a specified interface.
Step 4	Switch(config-if)# **atm ilmi-keepalive** [*seconds* [**retry** *number*]]	Configures ILMI keepalive.

Note If the ILMI VC (by default VCI = 16) is disabled, then the ILMI is disabled.

Examples

The following example shows how to enable ILMI autoconfiguration on ATM interface 3/0/3:

```
Switch(config)# interface atm 3/0/3
Switch(config-if)# atm auto-configuration
```

The following example shows how to enable ATM address registration on ATM interface 3/0/3:

```
Switch(config)# interface atm 3/0/3
Switch(config-if)# atm address-registration
```

Note If you use the **no atm address-registration** command to disable ILMI on this interface, the keepalives and responses to incoming ILMI queries continue to function. If you want ILMI to be completely disabled at this interface, use the **no atm ilmi-enable** command.

The following example shows how to configure the ILMI ATM interface 3/0/3 with a keepalive time of 20 seconds and retry count of 3:

```
Switch(config)# interface atm 3/0/3
Switch(config-if)# atm ilmi-keepalive 20 retry 3
```

In this example, the peer network element is polled every 20 seconds.

Proceed to the following section to confirm the ILMI interface configuration.

Configuring Per-Interface ILMI Address Prefixes

The ATM switch router allows configuration of per-interface ILMI address prefixes, so different address prefixes can be registered with end systems attached to different interfaces. When any per-interface ILMI address prefixes are configured, they override the prefix(es) derived from the first 13 bytes of the switch ATM address(es) for that specific interface.

Multiple ILMI address prefixes can be configured on each interface; for example, during ATM address migration.

To configure a per-interface ILMI address prefix, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm prefix** *13-byte-prefix*	Configures the ILMI address prefix.

Examples

The following example shows how to change the ATM address of the switch from the autoconfigured address 47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081.00 to the new address 47.0091.8100.5670.0000.0000.1122.0041.0b0a.1081.00:

```
Switch(config)# atm address 47.0091.8100.5670.0000.0000.1122...
Switch(config)# no atm address 47.0091.8100.0000.0041.0b0a.1081...
```

The following example shows how to configure an additional ATM address manually, or address prefix 47.0091.8100.0000.0003.c386.b301 on ATM interface 0/0/1:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm prefix 47.0091.8100.0000.0003.c386.b301
```

Displaying ILMI Address Prefix

Use the **show atm addresses** command to display the ILMI address prefix configuration for all interfaces or a specific interface.

To display the ILMI address prefix configuration for all interfaces, use the following EXEC command:

Command	Purpose
show atm addresses	Displays the interface ILMI address prefix configuration.

Example

The following example shows the ILMI address prefix configuration for all ATM interfaces:

```
Switch# show atm addresses

Switch Address(es):
  47.00918100000000410B0A1081.00410B0A1081.00 active
  47.00918100000000603E5ADB01.00603E5ADB01.00
  47.0091810056700000000001122.00400B0A1081.00

Soft VC Address(es):
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.00 ATM0/0/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.63 ATM0/0/0.99
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0010.00 ATM0/0/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0020.00 ATM0/0/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0030.00 ATM0/0/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1000.00 ATM0/1/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1010.00 ATM0/1/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1020.00 ATM0/1/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1030.00 ATM0/1/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8000.00 ATM1/0/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8010.00 ATM1/0/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8020.00 ATM1/0/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8030.00 ATM1/0/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9000.00 ATM1/1/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9010.00 ATM1/1/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9020.00 ATM1/1/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9030.00 ATM1/1/3

ILMI Switch Prefix(es):
  47.0091.8100.0000.0041.0b0a.1081
  47.0091.8100.0000.0060.3e5a.db01
  47.0091.8100.5670.0000.0000.1122

ILMI Configured Interface Prefix(es):

LECS Address(es):
```

Displaying the ILMI Interface Configuration

To show the ILMI interface configuration, use the following EXEC command:

Command	Purpose
show atm ilmi-status atm *card*/*subcard*/*port*	Shows the ILMI configuration on a per-port basis.

Example

The following example displays the ILMI status for ATM interface 3/0/0:

```
Switch# show atm ilmi-status atm 3/0/0

Interface : ATM3/0/0 Interface Type : Private NNI
ILMI VCC : (0, 16) ILMI Keepalive : Disabled
Configured Prefix(s) :
47.0091.8100.0000.0003.c386.b301
```

Configuring ATM Address Groups

ATM address groups allow more than one interface to have the same ATM address. These multiple connections provide load balancing for traffic from an end station.

Configure the interfaces in a group by performing the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm interface-group** *number*	Configures the ATM address group.

Example

The following example shows how to configure ATM interface 1/1/0 and ATM interface 3/0/1 in ATM address group 5:

```
Switch(config)# interface atm 1/1/0
Switch(config-if)# atm interface-group 5
Switch(config-if)# exit
Switch(config)# interface atm 3/0/1
Switch(config-if)# atm interface-group 5
```

Displaying ATM Address Group Configuration

To determine if an interface is a member of an ATM address group, use the following privileged EXEC command:

Command	Purpose
show running-config interface atm *card/subcard/port*	Shows the ILMI configuration on a per-port basis.

Example

The following example shows the ATM address group configuration for ATM interface 1/1/0 and ATM interface 3/0/1:

```
Switch# show running-config interface atm 1/1/0
Building configuration...

Current configuration:
!
→ interface ATM1/1/0
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
→ atm interface-group 5
 clock source free-running
end
Switch# show running-config interface atm 3/0/1
Building configuration...

Current configuration:
!
→ interface ATM3/0/1
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
→ atm interface-group 5
 clock source free-running
end
```

CHAPTER 11

Configuring ATM Routing and PNNI

This chapter describes the Interim Interswitch Signaling Protocol (IISP) and Private Network-Network Interface (PNNI) ATM routing protocol implementations on the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For conceptual and background information, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Overview

To place calls between ATM end systems, signaling consults either IISP, a static routing protocol, or PNNI, a dynamic routing protocol. PNNI provides quality of service (QoS) routes to signaling based on the QoS requirements specified in the call setup request.

Note The Cisco IOS Release 12.1(22)EB and later releases for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch router support processing of the pass along request bit (bit 4) in the compatibility instruction indicator field of a received unknown/unexpected message as described in the PNNI Specification Version 1.1. This feature is enabled by default and no CLI/SNMP support is required to enable it.

For detailed discussions of the following topics, refer to the *Guide to ATM Technology*:

- IISP routing
- PNNI signaling and routing
- Mechanisms and components of single-level and hierarchical PNNI

ATM Addresses

The autoconfigured ATM address of the ATM switch router suffices when implementing single-level PNNI. Hierarchical PNNI requires an addressing scheme to ensure global uniqueness of the ATM address and to plan for future network expansion.

For detailed discussions of the following related topics, refer to the *Guide to ATM Technology*:

- The autoconfigured ATM address for single-level PNNI
- E.164 AESA prefixes
- Designing an ATM address plan for hierarchical PNNI
- Obtaining registered ATM addresses

IISP Configuration

This section describes the procedures necessary for Interim Interswitch Signaling Protocol (IISP) configuration, and includes the following subsections:

- Configuring the Routing Mode, page 11-2
- Configuring the ATM Address, page 11-4
- Configuring Static Routes, page 11-6

Configuring the Routing Mode

The ATM routing software can be restricted to operate in static mode. In this mode, the call routing is restricted to only the static configuration of ATM routes, disabling operation of any dynamic ATM routing protocols, such as PNNI.

The **atm routing-mode** command is different from deleting all PNNI nodes using the **node** command and affects Integrated Local Management Interface (ILMI) autoconfiguration. If the switch is configured using static routing mode on each interface, the switch ILMI variable atmfAtmLayerNniSigVersion is set to IISP. This causes either of the following to happen:

- ILMI autoconfiguration on the interfaces between two switches determines the interface type as IISP.
- The switch on the other side indicates that the Network-Network Interface (NNI) signaling protocol is not supported.

Note The **atm routing-mode** command is activated only after the next software reload. The switch continues to operate in the current mode until the software is reloaded.

To configure the routing mode, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm routing-mode static**	Configures the ATM routing mode to static.
Step 2	Switch(config)# **end** Switch#	Exits configuration mode.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Writes the running configuration to the startup configuration.
Step 4	Switch# **reload**	Reloads the switch software.

Example

The following example shows how to use the **atm routing-mode static** command to restrict the switch operation to static routing mode:

```
Switch(config)# atm routing-mode static
This Configuration Will Not Take Effect Until Next Reload.
Switch(config)# end
Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
Switch# reload
```

The following example shows how to reset the switch operation back to PNNI if the switch is operating in static mode:

```
Switch(config)# no atm routing-mode static
This Configuration Will Not Take Effect Until Next Reload.
Switch(config)# end
Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
Switch# reload
```

Displaying the ATM Routing Mode Configuration

To display the ATM routing mode configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the ATM routing mode configuration.

Example

The following example shows the ATM routing mode configuration using the **more system:running-config** privileged EXEC command:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version 11.2
<information deleted>
!
hostname Switch
!
username dtate
ip rcmd remote-username dplatz
!
atm e164 translation-table
 e164 address 1111111 nsap-address 11.111111111111111111111111.112233445566.11
 e164 address 2222222 nsap-address 22.222222222222222222222222.112233445566.22
 e164 address 3333333 nsap-address 33.333333333333333333333333.112233445566.33
!
➔ atm routing-mode static
atm address 47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81.00
!
<information deleted>
```

Configuring the ATM Address

If you are planning to implement only a flat topology network (and have no future plans to migrate to PNNI hierarchy), you can skip this section and use the preconfigured ATM address assigned by Cisco Systems.

Note For information about ATM address considerations, see ATM Addresses, page 11-2.

To change the active ATM address, create a new address, verify that it exists, and then delete the current active address. Follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm address** *new-address-template*	Configures the ATM address for the switch.
Step 2	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 3	Switch# **show atm addresses**	Verifies the new address.
Step 4	Switch# **configure terminal** Switch(config)#	Enters configuration mode from the terminal.
Step 5	Switch(config)# **no atm address** *old-address-template*	Removes the old ATM address from the switch.

Example

The following example shows how to add the ATM address prefix 47.0091.8100.5670.000.0ca7.ce01. Using the ellipses (...) adds the default Media Access Control (MAC) address as the last six bytes.

```
Switch(config)# atm address 47.0091.8100.5670.0000.0ca7.ce01...
Switch(config)# no atm address 47.0091.8100.0000.0041.0b0a.1081...
```

Displaying the ATM Address Configuration

To display the ATM address configuration, use the following EXEC command:

Command	Purpose
show atm addresses	Displays the ATM address configuration.

Example

The following example shows the ATM address configuration using the **show atm addresses** EXEC command:

```
Switch# show atm addresses

Switch Address(es):
➔ 47.00918100000000410B0A1081.00410B0A1081.00 active
  47.00918100567000000CA7CE01.00410B0A1081.00

Soft VC Address(es):
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.00 ATM0/0/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.63 ATM0/0/0.99
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0010.00 ATM0/0/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0020.00 ATM0/0/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0030.00 ATM0/0/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1000.00 ATM0/1/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1010.00 ATM0/1/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1020.00 ATM0/1/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1030.00 ATM0/1/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8000.00 ATM1/0/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8010.00 ATM1/0/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8020.00 ATM1/0/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8030.00 ATM1/0/3
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9000.00 ATM1/1/0
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9010.00 ATM1/1/1
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9020.00 ATM1/1/2
  47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9030.00 ATM1/1/3

ILMI Switch Prefix(es):
  47.0091.8100.0000.0041.0b0a.1081
  47.0091.8100.0000.0060.3e5a.db01

ILMI Configured Interface Prefix(es):

LECS Address(es):
```

Configuring Static Routes

Use the **atm route** command to configure a static route. A static route attached to an interface allows all ATM addresses matching the configured address prefix to be reached through that interface.

Note For private User-Network Interface (UNI) interfaces where ILMI address registration is not used, internal-type static routes should be configured to a 19-byte address prefix representing the attached end system.

To configure a static route, use the following global configuration command:

Command	Purpose
atm route *addr-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** *numtype*]] [**internal**] [**scope** *org-scope*] [**aesa-gateway** *aesa-address*]	Specifies a static route to a reachable address prefix.

Examples

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0
```

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 configured with a scope 1 associated:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0 scope 1
```

Displaying the Static Route Configuration

To display the ATM static route configuration, use the following EXEC command:

Command	Purpose
show atm route	Displays the static route configuration.

Examples

The following example shows the ATM static route configuration using the **show atm route** privileged EXEC command:

```
Switch# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E 1   ATM0/0/0     DN 56  47.0091.8100.0000/56
S  E 1   ATM0/0/0     DN 0   47.0091.8100.0000.00/64
                             (E164 Address 1234567)
R SI 1   0            UP 0   47.0091.8100.0000.0041.0b0a.1081/104
R  I 1   ATM0         UP 0   47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R  I 1   ATM0         UP 0   47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R SI 1   0            UP 0   47.0091.8100.5670.0000.0000.0000/104
R  I 1   ATM0         UP 0   47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R  I 1   ATM0         UP 0   47.0091.8100.5670.0000.0000.0000.4000.0c/128
```

Configuring ATM Address Groups

ATM address groups allow more than one interface to have the same internal address prefix for the same static route. These multiple static routes provide load balancing for traffic from an end station.

Configure the interfaces in a group by performing the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm interface-group** *number*	Configures the ATM address group.

Example

The following example shows how to configure ATM interface 1/1/0 and ATM interface 3/0/1 in ATM address group 5:

```
Switch(config)# interface atm 1/1/0
Switch(config-if)# atm interface-group 5
Switch(config-if)# exit
Switch(config)# interface atm 3/0/1
Switch(config-if)# atm interface-group 5
```

Displaying ATM Address Group Configuration

To determine if an interface is a member of an ATM address group, use the following privileged EXEC command:

Command	Purpose
show running-config interface atm *card/subcard/port*	Shows the ILMI configuration on a per-port basis.

Example

The following example shows the ATM address group configuration for ATM interface 1/1/0 and ATM interface 3/0/1:

```
Switch# show running-config interface atm 1/1/0
Building configuration...

Current configuration:
!
➔ interface ATM1/1/0
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
➔ atm interface-group 5
 clock source free-running
end
Switch# show running-config interface atm 3/0/1
Building configuration...

Current configuration:
!
➔ interface ATM3/0/1
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
➔ atm interface-group 5
 clock source free-running
end
```

Basic PNNI Configuration

This section describes all the procedures necessary for a basic PNNI configuration and includes the following subsections:

- Configuring PNNI without Hierarchy, page 11-9
- Configuring the Lowest Level of the PNNI Hierarchy, page 11-9
- Configuring Higher Levels of the PNNI Hierarchy, page 11-16

Configuring PNNI without Hierarchy

The ATM switch router defaults to a working PNNI configuration suitable for operation in isolated flat topology ATM networks. The switch comes with a globally unique preconfigured ATM address. Manual configuration is not required if you:

- Have a flat network topology
- Do not plan to connect the switch to a service provider network
- Do not plan to migrate to a PNNI hierarchy in the future

If you plan to migrate your flat network topology to a PNNI hierarchical topology, proceed to the next section "Configuring the Lowest Level of the PNNI Hierarchy."

Configuring the Lowest Level of the PNNI Hierarchy

This section describes how to configure the lowest level of the PNNI hierarchy. The lowest-level nodes comprise the lowest level of the PNNI hierarchy. When only the lowest-level nodes are configured, there is no hierarchical structure. If your network is relatively small and you want the benefits of PNNI, but do not need the benefits of a hierarchical structure, follow the procedures in this section to configure the lowest level of the PNNI hierarchy.

To implement multiple levels of PNNI hierarchy, first complete the procedures in this section and then proceed to Configuring Higher Levels of the PNNI Hierarchy, page 11-16.

Configuring an ATM Address and PNNI Node Level

The ATM switch router is preconfigured as a single lowest-level PNNI node (locally identified as node 1) with a level of 56. The node ID and peer group ID are calculated based on the current active ATM address.

Note If you are planning to implement only a flat topology network (and have no future plans to migrate to PNNI hierarchy), you can skip this section and use the preconfigured ATM address.

To configure a node in a higher level of the PNNI hierarchy, the value of the node level must be a smaller number. For example, a three-level hierarchical network could progress from level 72 to level 64 to level 56. Notice that the level numbers graduate from largest at the lowest level (72) to smallest at the highest level (56).

To change the active ATM address you must create a new address, verify that it exists, and then delete the current active address. After you have entered the new ATM address, disable node 1 and then reenable it. At the same time, you can change the node level if required for your configuration. The identifiers for all higher level nodes are recalculated based on the new ATM address.

Caution Node IDs and peer group IDs are not recalculated until the node is disabled and then reenabled.

To change the active ATM address, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm address** *new-address-template*	Configures the new ATM address for the switch.
Step 2	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 3	Switch# **show atm addresses**	Verifies the new address.
Step 4	Switch# **configure terminal** Switch(config)#	Enters configuration mode from the terminal.
Step 5	Switch(config)# **no atm address** *old-address-template*	Removes the old ATM address from the switch.
Step 6	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode from the terminal.
Step 7	Switch(config-atm-router)# **node 1 disable** Switch(config-pnni-node)#	Disables the PNNI node.
Step 8	Switch(config-pnni-node)# **node 1 level** *number* **enable**	Reenables the node. You can also change the node level if required for your configuration.

Example

The following example changes the ATM address of the switch from the autoconfigured address 47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081.00 to the new address prefix 47.0091.8100.5670.0000.0000.1122.0041.0b0a.1081.00, and causes the node identifier and peer group identifier to be recalculated:

```
Switch(config)# atm address 47.0091.8100.5670.0000.0000.1122...
Switch(config)# no atm address 47.0091.8100.0000.0041.0b0a.1081...
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1 disable
Switch(config-pnni-node)# node 1 enable
```

Displaying the PNNI Node Configuration

To display the ATM PNNI node configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI node configuration.

Example

The following example shows the PNNI node configuration using the show **atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: eng_1
  System address          47.0091810000000002EB1FFE00.0002EB1FFE00.01
  Node ID          56:160:47.0091810000000002EB1FFE00.0002EB1FFE00.00
  Peer group ID        56:160:47.0000.0000.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 1, No. of neighbors 0
  Parent Node Index: 2
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Next resource poll in 3 seconds
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: Yes
```

Configuring Static Routes

Because PNNI is a dynamic routing protocol, static routes are not necessary between nodes that support PNNI. However, you can extend the routing capability of PNNI beyond nodes that support PNNI to:

- Connect to nodes outside of a peer group that do not support PNNI
- Define routes to end systems that do not support Integrated Local Management Interface (ILMI)

Use the **atm route** command to configure a static route. A static route attached to an interface allows all ATM addresses matching the configured address prefix to be reached through that interface.

Note Two PNNI peer groups can be connected using the IISP protocol. Connecting PNNI peer groups requires that a static route be configured on the IISP interfaces, allowing connections to be set up across the IISP link(s).

To configure a static route connection, use the following global configuration command:

Command	Purpose
atm route *addr-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** *numtype*]] [**internal**] [**scope** *org-scope*]	Specifies a static route to a reachable address prefix.

Examples

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0
```

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 configured with a scope 1 associated:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0 scope 1
```

Displaying the Static Route Configuration

To display the ATM static route configuration, use the following EXEC command:

Command	Purpose
show atm route	Displays the static route configuration.

Example

The following example shows the ATM static route configuration using the **show atm route** EXEC command:

```
Switch# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E 1   ATM0/0/0     DN 56  47.0091.8100.0000/56
S  E 1   ATM0/0/0     DN 0   47.0091.8100.0000.00/64
                             (E164 Address 1234567)
R SI 1   0            UP 0   47.0091.8100.0000.0041.0b0a.1081/104
R  I 1   ATM0         UP 0   47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R  I 1   ATM0         UP 0   47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R SI 1   0            UP 0   47.0091.8100.5670.0000.0000.0000/104
R  I 1   ATM0         UP 0   47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R  I 1   ATM0         UP 0   47.0091.8100.5670.0000.0000.0000.4000.0c/128
```

Configuring a Summary Address

You can configure summary addresses to reduce the amount of information advertised by a PNNI node and contribute to scalability in large networks. Each summary address consists of a single reachable address prefix that represents a collection of end system or node addresses. We recommend that you use summary addresses when all end system addresses that match the summary address are directly reachable from the node. However, this is not always required because routes are always selected by nodes advertising the longest matching prefix to a destination address.

By default, each lowest-level node has a summary address equal to the 13-byte address prefix of the ATM address of the switch. This address prefix is advertised into its peer group.

You can configure multiple addresses for a single switch which are used during ATM address migration. ILMI registers end systems with multiple prefixes during this period until an old address is removed. PNNI automatically creates 13-byte summary address prefixes from all of its ATM addresses.

You must configure summary addresses (other than the defaults) on each node. Each node can have multiple summary address prefixes. Use the **summary-address** command to manually configure summary address prefixes.

Note The **no auto-summary** command removes the default summary address(es). Use the **no auto-summary** command when systems that match the first 13-bytes of the ATM address(es) of your switch are attached to different switches. You can also use this command for security purposes.

To configure a summary address, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **no auto-summary**	Removes the default summary address(es).
Step 4	Switch(config-pnni-node)# **summary-address** *address-prefix*	Configures the ATM PNNI summary address prefix.

Example

The following example shows how to remove the default summary address(es) and add summary address 47.009181005670:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# no auto-summary
Switch(config-pnni-node)# summary-address 47.009181005670
```

Displaying the Summary Address Configuration

To display the ATM PNNI summary address configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni summary	Displays a summary of the PNNI hierarchy.

Example

The following example shows the ATM PNNI summary address configuration using the **show atm pnni summary** privileged EXEC command:

```
Switch# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   1  Int   N   Y    Y   47.0091.8100.0000.0040.0b0a.2a81/104
   2  Int   N   Y    N   47.01b1.0000.0000.0000.00/80
```

Configuring Scope Mapping

The PNNI address scope allows you to restrict advertised reachability information within configurable boundaries.

Note On UNI and IISP interfaces, the scope is specified in terms of organizational scope values ranging from 1 (local) to 15 (global). (Refer to the ATM Forum UNI Signaling 4.0 specification for more information.)

In PNNI networks, the scope is specified in terms of PNNI levels. The mapping from organizational scope values used at UNI and IISP interfaces to PNNI levels is configured on the lowest-level node. The mapping can be determined automatically (which is the default setting) or manually, depending on the configuration of the **scope mode** command.

In manual mode, whenever the level of node 1 is modified, the scope map should be reconfigured to avoid unintended suppression of reachability advertisements. Misconfiguration of the scope map might cause addresses to remain unadvertised.

In automatic mode, the UNI to PNNI level mapping is automatically reconfigured whenever the level of the node 1 is modified. The automatic reconfiguration avoids misconfigurations caused by node level modifications. Automatic adjustment of scope mapping uses the values shown in Table 11-1.

Table 11-1 Scope Mapping Table

Organizational Scope	ATM Forum PNNI 1.0 Default Level	Automatic Mode PNNI Level
1 to 3	96	Minimum (l,96)
4 to 5	80	Minimum (l,80)
6 to 7	72	Minimum (l,72)
8 to 10	64	Minimum (l,64)
11 to 12	48	Minimum (l,48)
13 to 14	32	Minimum (l,32)
15 (global)	0	0

Entering the **scope mode automatic** command ensures that all organizational scope values cover an area at least as wide as the current node's peer group. Configuring the scope mode to **manual** disables this feature and no changes can be made without explicit configuration.

To configure the PNNI scope mapping, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **scope mode manual**	Configures scope mode as manual.[1]
Step 4	Switch(config-pnni-node)# **scope map** *low-org-scope* [*high-org-scope*] **level** *number*	Configures node scope mapping.

1. You must enter the **scope mode manual** command to allow scope mapping configuration.

Example

The following example shows how to configure PNNI scope mapping manually so that organizational scope values 1 through 8 map to PNNI level 72:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# scope mode manual
Switch(config-pnni-node)# scope map 1 8 level 72
```

Displaying the Scope Mapping Configuration

To display the PNNI scope mapping configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni scope	Displays the node PNNI scope mapping configuration.

Example

The following example shows the ATM PNNI scope mapping configuration using the **show atm pnni scope** privileged EXEC command:

```
Switch# show atm pnni scope

UNI scope   PNNI Level
~~~~~~~~~   ~~~~~~~~~~
(1  - 10)      56
(11 - 12)      48
(13 - 14)      32
(15 - 15)      0

Scope mode: manual
```

Configuring Higher Levels of the PNNI Hierarchy

Once you have configured the lowest level of the PNNI hierarchy, you can configure the higher levels. To do so, you must configure peer group leaders (PGLs) and logical group nodes (LGNs).

For an explanation of PGLs and LGNs, as well as guidelines for creating a PNNI hierarchy, refer to the *Guide to ATM Technology*.

Configuring a Logical Group Node and Peer Group Identifier

The LGN is created only when the child node in the same switch (that is, the node whose parent configuration points to this node) is elected PGL of the child peer group.

The peer group identifier defaults to a value created from the first part of the child peer group identifier, and does not need to be specified. If you want a nondefault peer group identifier, you must configure all logical nodes within a peer group with the same peer group identifier.

Higher level nodes are only active if:

- A lower-level node specifies the higher-level node as a parent.
- The election leadership priority of the child node is configured with a non-zero value and is elected as the PGL.

To configure a LGN and peer group identifier, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* **level** *number* [**lowest**] [**peer-group-identifier** *dd:xxx*] [**enable** | **disable**]	Configures the logical node and optionally its peer group identifier. Configures each logical node in the peer group with the same peer group identifier. When you have more than one logical node on the same switch, you must specify a different index number to distinguish it from node 1.

Examples

The following example shows how to create a new node 2 with a level of 56 and a peer group identifier of 56:47009111223344:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 2 level 56 peer-group-identifier 56:47009111223344 enable
Switch(config-pnni-node)# end
```

Notice that the PNNI level and the first two digits of the peer group identifier are the same.

Displaying the Logical Group Node Configuration

To display the LGN configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the PNNI node information.

Example

The following example shows the PNNI node information using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node 2

PNNI node 2 is enabled and not running
  Node name: Switch.2.56
  System address          47.00918100000000000000001.000000000001.02
  Node ID            56:0:00.0000000000000000000000.000000000001.00
  Peer group ID        56:47.0091.1122.3344.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: No
```

Configuring the Node Name

PNNI node names default to names based on the host name. However, you can change the default node name to more accurately reflect the peer group. We recommend you chose a node name of 12 characters or less so that your screen displays remain nicely formatted and easy to read.

After a node name has been configured, it is distributed to all other nodes by PNNI flooding. This allows the node to be identified by its node name in PNNI **show** commands.

Note See Chapter 3, "Initially Configuring the ATM Switch Router," for information about configuring host names.

To configure the PNNI node name, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **name** *name*	Configures the node name.

Example

Configure the name of the node as eng_1 using the **name** command, as in the following example:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# name eng_1
```

Displaying the Node Name Configuration

To display the ATM PNNI node name configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI router configuration.

Example

This example shows how to display the ATM node name configuration using the **show atm pnni local-node** command from user EXEC mode:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
➔  Node name: eng_1
  System address          47.0091810000000002EB1FFE00.0002EB1FFE00.01
  Node ID          56:160:47.0091810000000002EB1FFE00.0002EB1FFE00.00
  Peer group ID        56:16.0347.0000.0000.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 1, No. of neighbors 0
  Parent Node Index: 2
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Next resource poll in 3 seconds
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: Yes
```

Configuring a Parent Node

For a node to be eligible to become a PGL within its own peer group, you must configure a parent node and a nonzero election leadership level (described in the following section, "Configuring the Node Election Leadership Priority"). If the node is elected a PGL, the node specified by the **parent** command becomes the parent node and represents the peer group at the next hierarchical level.

To configure a parent node, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index*	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **parent** *node-index*	Configures the parent node index.

Example

The following example shows how to create a parent node for node 1:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 1
Switch(config-pnni-node)# parent 2
```

Displaying the Parent Node Configuration

To display the parent node configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni hierarchy	Displays the PNNI hierarchy.

Example

The following example shows the ATM parent node information using the **show atm pnni hierarchy** privileged EXEC command:

```
Switch# show atm pnni hierarchy
Locally configured parent nodes:
  Node          Parent
  Index  Level  Index   Local-node Status     Node Name
  ~~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~
  1      80     2       Enabled/ Running      Switch
  2      72     N/A     Enabled/ Running      Switch.2.72
```

Configuring the Node Election Leadership Priority

Normally the node with the highest election leadership priority is elected PGL. If two nodes share the same election priority, the node with the highest node identifier becomes the PGL. To be eligible for election the configured priority must be greater than zero. You can configure multiple nodes in a peer group with nonzero leadership priority so that if one PGL becomes unreachable, the node configured with the next highest election leadership priority becomes the new PGL.

Note The choice of PGL does not directly affect the selection of routes across the peer group.

The control for election is done through the assignment of leadership priorities. We recommend that the leadership priority space be divided into three tiers:

- First tier: 1 to 49
- Second tier: 100 to 149
- Third tier: 200 to 205

This subdivision is used because when a node becomes PGL, it increases the advertised leadership priority by a value of 50. This avoids instabilities after election.

The following guidelines apply when configuring the node election leadership priority:

- Nodes that you do not want to become PGLs should remain with the default leadership priority value of 0.
- Unless you want to force one of the PGL candidates to be the PGL, you should assign all leadership priority values within the first tier. After a node is elected PGL, it remains PGL until it goes down or is configured to step down.
- If certain nodes should take precedence over nodes in the first tier, even if one is already PGL, leadership priority values can be assigned from the second tier. We recommend that you configure more than one node with a leadership priority value from this tier. This prevents one unstable node with a larger leadership priority value from repeatedly destabilizing the peer group.
- If you need a strict master leader, use the third tier.

Note The **election leadership-priority** command does not take effect unless a parent node has already been configured using the **node** and **parent** commands.

To configure the election leadership priority, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode from the terminal.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **election leadership-priority** *number*	Configures the election leadership priority. The configurable range is from 0 to 205.

Example

The following example shows how to change the election leadership priority for node 1 to 100:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 1
Switch(config-pnni-node)# election leadership-priority 100
```

Displaying Node Election Leadership Priority

To display the node election leadership priority, use one of the following privileged EXEC commands:

Command	Purpose
show atm pnni election	Displays the node election leadership priority.
show atm pnni election peers	Displays all nodes in the peer group.

Examples

The following example shows the election leadership priority using the **show atm pnni election** privileged EXEC command:

```
Switch# show atm pnni election

PGL Status.............: PGL
Preferred PGL..........: (1) Switch
Preferred PGL Priority.: 255
Active PGL.............: (1) Switch
Active PGL Priority....: 255
Active PGL For.........: 00:01:07
Current FSM State......: PGLE Operating: PGL
Last FSM State.........: PGLE Awaiting Unanimity
Last FSM Event.........: Unanimous Vote

Configured Priority....: 205
Advertised Priority....: 255
Conf. Parent Node Index: 2
PGL Init Interval......: 15 secs
Search Peer Interval...: 75 secs
Re-election Interval...: 15 secs
Override Delay.........: 30 secs
```

The following example shows all nodes in the peer group using the **show atm pnni election peers** command:

```
Switch# show atm pnni election peers

  Node No.   Priority   Connected   Preferred PGL
  ~~~~~~~~   ~~~~~~~~   ~~~~~~~~~   ~~~~~~~~~~~~~
  1          255        Yes         Switch
  9          0          Yes         Switch
  10         0          Yes         Switch
  11         0          Yes         Switch
  12         0          Yes         Switch
```

Configuring a Summary Address

Summary addresses can be used to decrease the amount of information advertised by a PNNI node. Summary addresses should only be used when all end system addresses that match the summary address are directly reachable from this node. However, this is not always required because routes are always selected to nodes advertising the longest matching prefix to a destination address.

A single default summary address is configured for each logical group node (LGN) in the PNNI hierarchy. The length of that summary for any LGN equals the level of the child peer group, and its value is equal to the first level bits of the child peer group identifier. This address prefix is advertised into the LGN's peer group.

Summary addresses other than defaults must be explicitly configured on each node. A node can have multiple summary address prefixes. Note also that every node in a peer group that has a potential to become a peer group leader (PGL) should have the same summary address lists in its parent node configuration.

Note The **no auto-summary** command removes the default summary address(es). Use the **no auto-summary** command when systems that match the first 13-bytes of the ATM address(es) of your switch are attached to different switches.

To configure the ATM PNNI summary address prefix, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **no auto-summary**	Removes the default summary address(es).
Step 4	Switch(config-pnni-node)# **summary-address** *address-prefix*	Configures the ATM PNNI summary address prefix.

Example

The following example shows how to remove the default summary address(es) and add summary address 47.009181005670:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# no auto-summary
Switch(config-pnni-node)# summary-address 47.009181005670
```

Displaying the Summary Address Configuration

To display the ATM PNNI summary address configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni summary	Displays the ATM PNNI summary address configuration.

Example

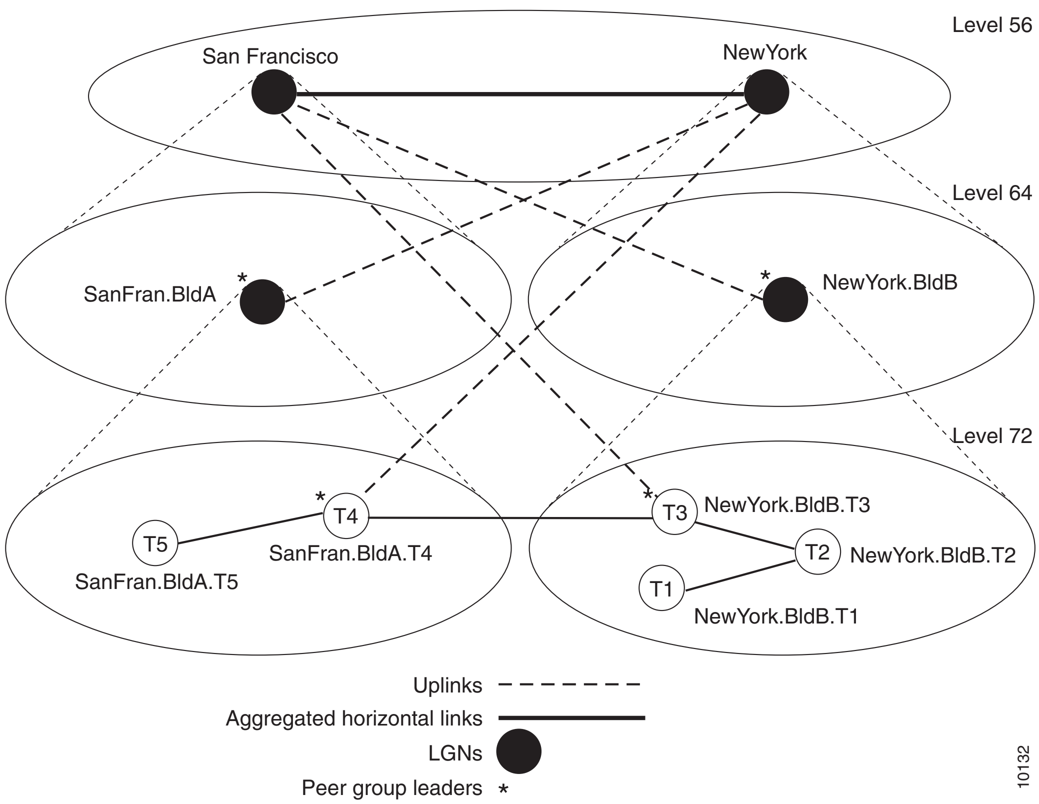
The following example shows the ATM PNNI summary address configuration using the **show atm pnni summary** privileged EXEC command:

```
Switch# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1   Int   N   Y    Y   47.0091.8100.0000.0040.0b0a.2a81/104
  2   Int   N   Y    N   47.01b1.0000.0000.0000.00/80
```

PNNI Hierarchy Configuration Example

An example configuration for a three-level hierarchical topology is shown in Figure 11-1. The example shows the configuration of only five switches, although there can be many other switches in each peer group.

Figure 11-1 Example Three-Level Hierarchical Topology



At the lowest level (level 72), the hierarchy represents two separate peer groups. Each of the four switches named T2 to T5 are eligible to become a peer group leader (PGL) at two levels, and each has two configured ancestor nodes (a parent node or a parent node's parent). Switch T1 has no configured ancestor nodes and is not eligible to become a PGL. As a result of the peer group leader election at the lowest level, switches T4 and T3 become leaders of their peer groups. Therefore, each switch creates an LGN at the second level (level 64) of the hierarchy. As a result of the election at the second level of the hierarchy, logical group nodes (LGNs) SanFran.BldA and NewYork.BldB are elected as PGLs, creating LGNs at the highest level of the hierarchy (level 56). At that level, the uplinks that have been induced through level 64 form an aggregated horizontal link within the common peer group at level 56.

Examples

The sections that follow show the configurations for each switch and the outputs of the **show atm pnni local-node** command. Some of the output text has been suppressed because it is not relevant to the example.

Switch NewYork.BldB.T1 Configuration

```
hostname NewYork.BldB.T1
atm address 47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a01.00
atm router pnni
  node 1 level 72 lowest
  redistribute atm-static

NewYork.BldB.T1# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T1
  System address          47.009144556677114410111233.00603E7B3A01.01
  Node ID          72:160:47.009144556677114410111233.00603E7B3A01.00
  Peer group ID        72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 0 0, No. of interfaces 3, No. of neighbors 2
  Parent Node Index: NONE

<information deleted>
```

Switch NewYork.BldB.T2 Configuration

```
hostname NewYork.BldB.T2
atm address 47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01.00
atm router pnni
node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 40
 node 2 level 64
  parent 3
  election leadership-priority 40
  name NewYork.BldB
 node 3 level 56
  name NewYork

NewYork.BldB.T2# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T2
  System address          47.009144556677114410111244.00603E5BBC01.01
  Node ID          72:160:47.009144556677114410111244.00603E5BBC01.00
  Peer group ID        72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 40 40, No. of interfaces 3, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and not running
```

```
  Node name: NewYork.BldB
  System address          47.00914455667711441011244.00603E5BBC01.02
  Node ID           64:72:47.00914455667711440000000000.00603E5BBC01.00
  Peer group ID        64:47.0091.4455.6677.1100.0000.0000
  Level 64, Priority 40 40, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and not running
  Node name: NewYork
  System address          47.00914455667711441011244.00603E5BBC01.03
  Node ID           56:64:47.00914455667711000000000000.00603E5BBC01.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>
```

Switch NewYork.BldB.T3 Configuration

```
hostname NewYork.BldB.T3
atm address 47.0091.4455.6677.1144.1011.1255.0060.3e5b.c401.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 45
 node 2 level 64
  parent 3
  election leadership-priority 45
  name NewYork.BldB
 node 3 level 56
  name NewYork

NewYork.BldB.T3# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T3
  System address          47.00914455667711441011255.00603E5BC401.01
  Node ID          72:160:47.00914455667711441011255.00603E5BC401.00
  Peer group ID        72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 45 95, No. of interfaces 4, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and running
  Node name: NewYork.BldB
  System address          47.00914455667711441011255.00603E5BC401.02
  Node ID           64:72:47.00914455667711440000000000.00603E5BC401.00
  Peer group ID        64:47.0091.4455.6677.1100.0000.0000
  Level 64, Priority 45 95, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and running
  Node name: NewYork
  System address          47.00914455667711441011255.00603E5BC401.03
  Node ID           56:64:47.00914455667711000000000000.00603E5BC401.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 1
```

```
  Parent Node Index: NONE

<information deleted>
```

Switch SanFran.BldA.T4 Configuration

```
hostname SanFran.BldA.T4
atm address 47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 45
 node 2 level 64
  parent 3
  election leadership-priority 45
  name SanFran.BldA
 node 3 level 56
  name SanFran

SanFran.BldA.T4# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T4
  System address          47.009144556677223310111266.00603E7B2001.01
  Node ID          72:160:47.009144556677223310111266.00603E7B2001.00
  Peer group ID        72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 45 95, No. of interfaces 4, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and running
  Node name: SanFran.BldA
  System address          47.009144556677223310111266.00603E7B2001.02
  Node ID           64:72:47.009144556677223300000000.00603E7B2001.00
  Peer group ID        64:47.0091.4455.6677.2200.0000.0000
  Level 64, Priority 45 95, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3
<information deleted>

PNNI node 3 is enabled and running
  Node name: SanFran
  System address          47.009144556677223310111266.00603E7B2001.03
  Node ID           56:64:47.009144556677220000000000.00603E7B2001.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 1
  Parent Node Index: NONE

<information deleted>
```

Switch SanFran.BldA.T5 Configuration

```
hostname SanFran.BldA.T5
atm address 47.0091.4455.6677.2233.1011.1244.0060.3e7b.2401.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 10
 node 2 level 64
  parent 3
  election leadership-priority 40
  name SanFran.BldA
 node 3 level 56
  name SanFran

SanFran.BldA.T5# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T5
  System address          47.009144556677223310111244.00603E7B2401.01
  Node ID          72:160:47.009144556677223310111244.00603E7B2401.00
  Peer group ID        72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 10 10, No. of interfaces 2, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and not running
  Node name: SanFran.BldA
  System address          47.009144556677223310111244.00603E7B2401.02
  Node ID           64:72:47.009144556677223300000000.00603E7B2401.00
  Peer group ID        64:47.0091.4455.6677.2200.0000.0000
  Level 64, Priority 40 40, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and not running
  Node name: SanFran
  System address          47.009144556677223310111244.00603E7B2401.03
  Node ID           56:64:47.009144556677220000000000.00603E7B2401.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>
```

Advanced PNNI Configuration

This section describes how to configure advanced PNNI features. The advanced features described in this section are not required to enable PNNI, but are provided to tune your network performance.

For additional information about the features described in this section, refer to the *Guide to ATM Technology*.

This section includes the following subsections:

Tuning Route Selection

The tasks described in the following subsections are used to tune the mechanisms by which routes are selected in your PNNI network.

Configuring Background Route Computation

The ATM switch router supports the following two route selection modes:

- On-demand—A separate route computation is performed each time a SETUP or ADD PARTY message is received over a User-Network Interface (UNI) or Interim Interswitch Signaling Protocol (IISP) interface. In this mode, the most recent topology information received by this node is always used for each setup request.
- Background routes—Call setups are routed using precomputed routing trees. In this mode, multiple background trees are precomputed for several service categories and quality of service (QoS) metrics. If no route can be found in the multiple background trees that satisfies the QoS requirements of a particular call, route selection reverts to on-demand route computation.

The background routes mode should be enabled in large networks where it usually exhibits less stringent processing requirements and better scalability. Route computation is performed at almost every poll interval when a significant change in the topology of the network is reported or when significant threshold changes have occurred since the last route computation.

To configure the background route computation, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **background-routes-enable** [**insignificant-threshold number**] [**poll-interval** *seconds*]	Enables background routes and configures background route parameters.

Example

The following example shows how to enable background routes and configures the background routes poll interval to 30 seconds:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# background-routes-enable poll-interval 30
```

Displaying the Background Route Computation Configuration

To display the background route configuration, use the following privileged EXEC commands:

Command	Purpose
show atm pnni background status	Displays the background route configuration.
show atm pnni background routes	Displays background routing tables.

Examples

The following example shows the ATM PNNI background route configuration using the **show atm pnni background status** privileged EXEC command:

```
Switch# show atm pnni background status

Background Route Computation is Enabled
Background Interval is set at 10 seconds
Background Insignificant Threshold is set at 32
```

The following example shows the ATM PNNI background route tables for constant bit rate (CBR) using the **show atm pnni background routes** privileged EXEC command:

```
Switch# show atm pnni background routes cbr
  Background Routes From CBR/AW Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  Background Routes From CBR/CDV Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
```

```
  Background Routes From CBR/CTD Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  Background Routes From CBR/CTD Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
```

Configuring Link Selection

Link selection applies to parallel PNNI links between two switches. Link selection allows you to choose the method the switch uses during call setup for selecting one link among multiple parallel links to forward the call.

Note Calls always use the load balance method over parallel IISP links between two switches.

Table 11-2 lists the PNNI link selection methods from which you can choose.

Table 11-2 PNNI Link Selection Methods

Precedence Order	Method	Description	Service Category Availability
1	admin-weight-minimize	Places the call on the link with the lowest administrative weight.	CBR[1], VBR-RT[2], VBR-NRT[3]
2	blocking-minimize	Places the call on the link so that higher bandwidth is available for subsequent calls, thus minimizing call blocking.	CBR, VBR-RT, VBR-NRT
3	transmit-speed-maximize	Places the call on the highest speed link.	CBR, VBR-RT, VBR-NRT
4	load-balance	Places the call on the link so that the load is balanced among parallel links for a group.	CBR, VBR-RT, VBR-NRT, ABR[4], UBR[5]

1. CBR = constant bit rate
2. VBR-RT = variable bit rate real time
3. VBR-NRT = variable bit rate non-real time
4. ABR = available bit rate
5. UBR = unspecified bit rate

The switch applies a single link selection method for a group of parallel links connected to a neighbor switch. If multiple links within this group are configured with a different link selection method, then the switch selects a method according to the order of precedence as shown in Table 11-2.

The link selection feature allows you to specify one or more links among the parallel links as an alternate (or backup) link. An alternate link is a link that is used only when all other non-alternate links are either down or full. Alternate links are not considered part of the parallel link group targeted for link selection. Calls are always load balanced over multiple parallel alternate links by default.

To configure the PNNI link selection feature, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies an ATM interface and enter interface configuration mode.
Step 2	Switch(config-if)# **atm pnni link-selection** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr** | **all**} {**admin-weight-minimize** | **alternate** | **blocking-minimize** | **load-balance** | **transmit-speed-maximize**}	Configures ATM PNNI link selection for a specific link.

Examples

The following example shows how to configure link selection on ATM interface 0/0/0 with a VBR-NRT service category and transmit-speed-maximize mode:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni link-selection vbr-nrt transmit-speed-maximize
```

The following example shows how to configure link selection on ATM interface 0/0/0 with a CBR service category and then designate the link as an alternate:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni link-selection cbr alternate
```

Displaying the Link Selection Configuration

To display the ATM PNNI link selection configuration, use the following EXEC command:

Command	Purpose
show atm pnni neighbor	Displays the ATM PNNI link selection configuration.

Example

The following example shows the detailed PNNI link selection configuration using the **show atm pnni neighbor** EXEC command:

```
Switch# show atm pnni neighbor

Neighbors For Node (Index 1, Level 56)

  Neighbor Name: XXXXXX, Node number: 9
  Neighbor Node Id: 56:160:47.00918100000000E04FACB401.00E04FACB401.00
  Neighboring Peer State: Full
  Link Selection For CBR    : minimize blocking of future calls
  Link Selection For VBR-RT : minimize blocking of future calls
  Link Selection For VBR-NRT: minimize blocking of future calls
  Link Selection For ABR    : balance load
  Link Selection For UBR    : balance load
   Port                      Remote Port Id             Hello state
   ATM4/0/0                  ATM3/1/1                   2way_in  (Flood Port)
Switch#
```

Configuring the Maximum Administrative Weight Percentage

The maximum administrative weight percentage feature, a generalized form of a hop count limit, allows you to prevent the use of alternate routes that consume too many network resources. The maximum acceptable administrative weight is equal to the specified percentage of the least administrative weight of any route to the destination (from the background routing tables).

To configure the maximum AW percentage, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **max-admin-weight-percentage** *percent*	Configures the maximum AW percentage. The value can range from 100 to 2000.

Note The **max-admin-weight-percentage** command only takes effect if background route computation is enabled. See Configuring Background Route Computation, page 11-29.

Example

The following example shows how to configure the node maximum AW percentage value as 300:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# max-admin-weight-percentage 300
```

Displaying the Maximum Administrative Weight Percentage Configuration

To display the node ATM PNNI maximum AW percentage configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the node ATM PNNI maximum AW configuration.

Example

The following example shows the maximum AW percentage configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
  Node name: eng_1
  System address 47.00918100000000000001212.121212121212.00
  Node ID 56:160:47.00918100000000000001212.121212121212.00
  Peer group ID 56:47.0091.8100.0000.0000.0000.0000
  Level 56, Priority 0, No. of interface 4, No. of neighbor 1

  Hello interval 15 sec, inactivity factor 5, Hello hold-down 10 tenths of sec
  Ack-delay 2 sec, retransmit interval 10 sec, rm-poll interval 10 sec
  PTSE refresh interval 90 sec, lifetime factor 7, minPTSEinterval 1000 msec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: linespeed
➔ Max admin weight percentage: 300
  Next RM poll in 3 seconds
```

Configuring the Precedence

The route selection algorithm chooses routes to particular destinations using the longest match reachable address prefixes known to the switch. When there are multiple longest match reachable address prefixes known to the switch, the route selection algorithm first attempts to find routes to reachable addresses with types of greatest precedence. Among multiple longest match reachable address prefixes of the same type, routes with the least total administrative weight are chosen first.

Local internal reachable addresses, whether learned via Integrated Local Management Interface (ILMI) or as static routes, are given highest precedence or a precedence value of one. The precedence of other reachable address types is configurable.

To configure the precedence of reachable addresses, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **precedence** [**pnni-remote-exterior** *value* | **pnni-remote-exterior-metrics** *value* | **pnni-remote-internal** *value* | **pnni-remote-internal-metrics** *value* | **static-local-exterior** *value* | **static-local-exterior-metrics** *value* | **static-local-internal-metrics** *value*]	Enters PNNI precedence and configure the PNNI node.

Example

The following example shows how to configure all PNNI remote exterior routes with a precedence value of 4:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# precedence pnni-remote-exterior 4
```

Displaying Precedence Configuration

To display the ATM PNNI route determination precedence configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni precedence	Displays the node ATM PNNI route determination precedence configuration.

Example

The following example shows the ATM PNNI route determination precedence configuration using the **show atm pnni precedence** privileged EXEC command:

```
Switch# show atm pnni precedence
                                 Working   Default
  Prefix Poa Type                Priority  Priority
  -----------------------------  --------  --------
  local-internal                    1         1
  static-local-internal-metrics     2         2
  static-local-exterior             3         3
  static-local-exterior-metrics     2         2
  pnni-remote-internal              2         2
  pnni-remote-internal-metrics      2         2
→ pnni-remote-exterior              4         4
  pnni-remote-exterior-metrics      2         2
```

Configuring Explicit Paths

The explicit path feature enables you to manually configure either a fully specified or partially specified path for routing soft permanent virtual channels (soft PVC) and soft permanent virtual path (soft PVP) connections. Once these routes are configured, up to three explicit paths might be applied to these connections.

A fully specified path includes all adjacent nodes (and optionally the corresponding exit port) for all segments of the path. A partially specified path consists of one or more segment target nodes that should appear in their proper order in the explicit path. The standard routing algorithm is used to determine all unspecified parts of the partially specified path.

You can specify a path name for an explicit path and the switch assigns the next available unused *path-id* value, or you can choose the *path-id* value and assign or modify its name.

To configure an explicit path on a circuit emulation services (CES) VC, see the section Configuring Explicit Paths on CES VCs, page 19-61.

To enter the PNNI explicit path configuration mode, use the following global configuration command:

Command	Purpose
atm pnni explicit-path {**identifier** *path-id-number* [**name** *path-name*] | **name** *path-name*} [**enable** | **disable**]	Enters the PNNI explicit path configuration mode.

The **disable** option can be used to prevent an explicit path from being used for routing while it is being configured, if any soft connections already reference it. If the explicit path has not been created, the initial default is to enable the explicit path upon configuration.

Example

The following example shows how to enter the PNNI explicit path configuration mode for a path named boston_2.path1:

```
Switch(config)# atm pnni explicit-path name boston_2.path1
Switch(cfg-pnni-expl-path)#
```

Adding Entries to the Explicit Path

Once in PNNI explicit path configuration mode, you can use the following subcommands repeatedly to build up the ordered list that specifies the explicit path:

Command	Purpose
next-node {*name-string* | *node-id* | *node-id-prefix*} [**port** *hex-port-id* | **agg-token** *hex-agg-token-id*]	The **next-node** keyword specifies the next adjacent node for fully specified paths. Add next PNNI explicit path entry with this command.
segment-target {*name-string* | *node-id* | *node-id-prefix*} [**port** *hex-port-id* | **agg-token** *hex-agg-token-id*]	The **segment-target** keyword specifies the target node for cases where the path through intermediate nodes should be automatically routed.
exclude-node {*name-string* | *node-id* | *node-id-prefix*} [**port** *hex-port-id* | **agg-token** *hex-agg-token-id*]	The **exclude-node** keyword specifies nodes or ports that are excluded from all partial path segments.

Node IDs can be entered either with the full 22-byte length address or as a Node ID prefix with a length of 15 or more bytes. To specify routes that include higher level nodes (parent LGNs) for other peer groups, we recommend that you enter exactly 15 bytes so that the address remains valid in the event of a PGL update.

Node IDs appear in the following format:

dec : *dec* : *13-20 hex digits*

Node names can be entered instead of Node IDs. If names are used to identify higher level LGNs, the resulting explicit paths are not guaranteed to remain valid if the PGL changes in the neighboring peer group. To prevent invalid paths, configure all parent LGNs (for all potential PGL nodes) with the same node name.

Optionally, an exit port can be specified for any entry. The port should be specified as a *hex-port-id* rather than a *port-name*. For excluded entries, only this port is excluded from the path.

Since the port ID could change if the following neighbor peer group changes PGL leaders, the aggregation token is used in place of the port ID for nodes with higher level LGNs. The LGN aggregation token can only identify the port uniquely if the following entry is a next-node entry. Aggregation tokens are not allowed for excluded nodes.

Example

The following example shows how to configure an explicit path list consisting of four entries. The first two are adjacent nodes and, in one case, an exit port is specified. Next, a partially-specified segment to the node chicago_2 is configured, several hops away. Finally, a higher level LGN node adjacent to chicago_2 is configured, which is specified by its 15-byte Node ID prefix.

```
Switch(cfg-pnni-expl-path)# next-node dallas_2
Switch(cfg-pnni-expl-path)# next-node dallas_4 port 80003004
Switch(cfg-pnni-expl-path)# segment-target chicago_2
Switch(cfg-pnni-expl-path)# next-node 40:72:47.00918100000106000000000
```

Displaying Node IDs

To display the node IDs that correspond to named nodes in a network, use either of the following EXEC commands:

Command	Purpose
show atm pnni identifier	Displays the node IDs.
show atm pnni topology node *name-or-number*	Displays the node IDs.

Displaying Hex-Port-IDs

Since the explicit path subcommands require a *hex-port-id* rather than a *port name*, use either of the following EXEC commands to display the corresponding *hex-port-ids* for a node:

Command	Purpose
show atm pnni identifiers *node-number* **port**	Displays hex-port-ids for a node.
show atm pnni topology node *node-number* **hex-port-id**	Displays hex-port-ids for a node.

Editing Entries within the Explicit Path

Each entry has an index that gives its relative position within the list. Indices are used as an aid to edit an explicit path. The entire current list showing the entry index displays after each entry is added, or it is redisplayed when you use the **list** keyword.

The optional **index** keyword allows the exact index to be specified for an entry. If no index is specified for a new entry, it always defaults to one higher than the last path entry. If the index matches the index of an existing entry, the index is overwritten with new information. The **no** form deletes an existing entry for a given index.

Example

The following example shows the original path:

```
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2
2 next-node dallas_4 port 80003004
3 segment   chicago_2
4 next-node 40:72:47.00918100000010600000000O.
```

You can modify the first entry to add an exit port for the original path. As shown in the following example, use the **index** keyword to specify the index of the entry to modify:

```
dallas_1 (cfg-pnni-expl-path)# index 1 next-node dallas_2 port 80000000
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2 port 80000000
2 next-node dallas_4 port 80003004
3 segment   chicago_2
4 next-node 40:72:47.00918100000010600000000O.
```

The **append-after** keyword adds a path entry after the specified index. Renumbering the following path entries, if necessary, to make room for the new entry.

Example

If there are four **next-node** entries labelled as index 1 through 4, you can squeeze a new entry in after index 2 (using the **append-after** keyword), resulting in index 3. The following two entries are automatically renumbered to indexes 4 and 5 in order to make room for index 3.

```
dallas_1(cfg-pnni-expl-path)# append 2 next-node st_louis
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2 port 80000000
2 next-node dallas_4 port 80003004
3 next-node st_louis
4 segment   chicago_2
5 next-node 40:72:47.00918100000010600000000O.
```

Displaying Explicit Path Configuration

To display the PNNI explicit path configuration, use the following EXEC command:

Command	Purpose
s**how atm pnni explicit-path** [{**name** *path-name* | **identifier** *path-id*} [**upto** *index*]] [**detail**]	Displays the PNNI explicit path configuration.

Example

The following example shows a summary of explicit paths:

```
Switch# show atm pnni explicit-paths
Summary of configured Explicit Paths:
 PathId Status       UpTo  Routable AdminWt Explicit Path Name
 ~~~~~~ ~~~~~~~~~~~  ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~~~~~~~~~~
 1      enabled      3     yes      10040   dallas_4.path1
 2      enabled      6     yes      15120   chicago_2.path1
 3      enabled      2     yes      10080   chicago_2.path2
 4      enabled      2     yes      20595   new_york.path1
```

The following example shows the detailed configuration including any known warnings and error messages for a non-routable explicit path named new_york.path2:

```
Switch# show atm pnni explicit-paths name new_york.path2 detail
 PathId Status       UpTo  Routable AdminWt Explicit Path Name
 ~~~~~~ ~~~~~~~~~~~  ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~~~~~~~~~~
 1      enabled      4     no       0       new_york.path2
  PNNI routing err_code for UBR call = 6 (PNNI_DEST_UNREACHABLE)

  Entry Type      Node [Port] specifier
  ~~~~~ ~~~~~~~~~ ~~~~~~~~~~~~~~~~~~~~~~
  1     next-node dallas_2
  2     next-node dallas_4 port 80000004
                  Warning:Entry index 2 specifies a non-routable port
  3     next-node wash_dc_1
                  Warning:Entry index 3 has no connectivity from prior node
  4     segment   new_york.2.40
```

Note The **upto** keyword can be used for troubleshooting explicit paths that are shown as non-routable. Routable status is only calculated up to the specified path entry index which allows the first failing path entry to be isolated.

Tuning Topology Attributes

The tasks in the following subsections describe how to configure attributes that affect the network topology.

Configuring the Global Administrative Weight Mode

Administrative weight is the primary routing metric for minimizing use of network resources. You can configure the administrative weight to indicate the relative desirability of using a link. For example, assigning equal administrative weight to all links in the network minimizes the number of hops used by each connection.

To configure the administrative weight mode, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **administrative-weight** {**linespeed** | **uniform**}	Configures the administrative weight for all node connections.

Example

The following example shows how to configure the administrative weight for the node as line speed:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# administrative-weight linespeed
```

Displaying the Administrative Weight Mode Configuration

To display the administrative weight configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the AW configuration for the node.

Example

The following example shows the AW configuration for the node using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
  Node name: switch
  System address 47.00918100000000000000001212.121212121212.00
  Node ID 56:160:47.00918100000000000000001212.121212121212.00
  Peer group ID 56:47.0091.8100.0000.0000.0000.0000
  Level 56, Priority 0, No. of interface 4, No. of neighbor 1

  Hello interval 15 sec, inactivity factor 5, Hello hold-down 10 tenths of sec
  Ack-delay 2 sec, retransmit interval 10 sec, rm-poll interval 10 sec
  PTSE refresh interval 90 sec, lifetime factor 7, minPTSEinterval 1000 msec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: linespeed
  Max admin weight percentage: 300
  Next RM poll in 3 seconds
```

Configuring Administrative Weight Per Interface

In addition to the global administrative weight (AW), you can also configure the administrative weight for an interface. To configure the administrative weight on an interface, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm pnni admin-weight** *number service-category*	Configures the ATM AW for this link.

Example

The following example shows how to configure ATM interface 0/0/0 with ATM PNNI AW of 7560 for traffic class ABR:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni admin-weight 7560 abr
```

Displaying the Administrative Weight Per Interface Configuration

To display the ATM PNNI interface AW configuration, use the following EXEC command:

Command	Purpose
show atm pnni [**interface atm** *card*/*subcard*/*port*] [**detail**]	Displays the interface ATM PNNI AW configuration.

Example

The following example shows the AW configuration for interface 0/0/0 using the **show atm pnni interface** EXEC command:

```
Switch# show atm pnni interface atm 0/0/0 detail

Port ATM0/0/0 is up  , Hello state 2way_in with node eng_18
    Next hello occurs in 11 seconds, Dead timer fires in 73 seconds
    CBR    : AW 5040 MCR 155519 ACR 147743 CTD 154 CDV 138 CLR0 10 CLR01 10
    VBR-RT : AW 5040 MCR 155519 ACR 155519 CTD 707 CDV 691 CLR0 8 CLR01 8
    VBR-NRT: AW 5040 MCR 155519 ACR 155519 CLR0 8 CLR01 8
    ABR    : AW 5040 MCR 155519 ACR 0
    UBR    : AW 5040 MCR 155519
    Remote node ID 56:160:47.00918100000000613E7B2F01.00613E7B2F99.00
    Remote node address 47.00918100000000613E7B2F01.00613E7B2F99.00
    Remote port ID  ATM0/1/2 (80102000) (0)
```

Configuring Transit Restriction

Transit calls originate from another ATM switch and pass through the switch. Some edge switches might want to eliminate this transit traffic and only allow traffic originating or terminating at the switch.

To configure a transit restriction, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **transit-restricted**	Enables transit restricted on this node.

Example

The following example shows how to enable the transit-restricted feature:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# transit-restricted
```

Displaying the Transit Restriction Configuration

To display the ATM PNNI transit-restriction configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM configuration.

Example

The following example shows the ATM PNNI transit-restriction configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
  PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
➔   Node Does Not Allow Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
    Redistributing static routes: Yes
```

Configuring Redistribution

Redistribution instructs PNNI to distribute reachability information from non-PNNI sources throughout the PNNI routing domain. The ATM switch router supports redistribution of static routes, such as those configured on Interim Interswitch Signaling Protocol (IISP) interfaces.

Note By default, redistribution of static routes is enabled.

To enable redistribution of static routes, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **redistribute atm-static**	Enables redistribution of static routes.

Example

The following example shows how to enable redistribution of static routes:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# redistribute atm-static
```

Displaying the Redistribution Configuration

To display the node redistribution configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the node redistribution configuration.

Example

The following example shows the node redistribution configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
  PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
    Node Allows Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
➔   Redistributing static routes: Yes
```

Configuring Aggregation Token

The aggregation token controls the grouping of multiple physical links into logical links. Uplinks to the same higher level node, or upnode, with the same aggregation token value, are represented at a higher level as horizontal aggregated links. Resource Availability Information Groups (RAIGs) are computed according to the aggregation algorithm.

To specify an aggregation token value, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies the ATM interface.
Step 2	Switch(config-if)# **atm pnni aggregation-token** *value*	Enters a value for the aggregation-token on the ATM interface.

Example

The following example shows how to configure an aggregation token on ATM interface 1/0/1:

```
Switch(config)# interface atm 1/0/1
Switch(config-if)# atm pnni aggregation-token 100
```

Displaying the Aggregation Token Configuration

To display the aggregation token configuration, use the following EXEC command:

Command	Purpose
show atm pnni interface atm *card/subcard/port* [**detail**]	Displays the interface PNNI configuration.

Examples

The following example shows the aggregation token value for all interfaces using the **show atm pnni interface** EXEC command:

```
NewYork.BldB.T3# show atm pnni interface

PNNI Interface(s) for local-node 1 (level=56):
  Local Port    Type  RCC Hello St Deriv Agg  Remote Port   Rem Node(No./Name)
  ~~~~~~~~~~~~~ ~~~~~ ~~~ ~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~~~~ ~~~~~~~~~~~~~~~~~~
  ATM0/0/2      Phy   UP  comm_out 2          ATM0/0/3      - SanFran.BldA.T4
  ATM0/1/2      Phy   DN  down     35
  ATM0/1/3      Phy   UP  2way_in  0          ATM1/1/3      10 NewYork.BldB.T1
NewYork.BldB.T3#
```

The following example shows the aggregation token value details for a specific interface using the **show atm pnni interface** EXEC command with the **detail** keyword:

```
NewYork.BldB.T3# show atm pnni interface atm 0/0/2 detail

PNNI Interface(s) for local-node 1 (level=56):

Port ATM0/0/2 RCC is up  , Hello state common_out with node SanFran.BldA.T4
  Next hello occurs in 4 seconds, Dead timer fires in 72 seconds
  CBR    : AW 5040 MCR 155519 ACR 147743 CTD 154 CDV 138 CLR0 10 CLR01 10
  VBR-RT : AW 5040 MCR 155519 ACR 155519 CTD 707 CDV 691 CLR0 8 CLR01 8
  VBR-NRT: AW 5040 MCR 155519 ACR 155519 CLR0 8 CLR01 8
  ABR    : AW 5040 MCR 155519 ACR 0
  UBR    : AW 5040 MCR 155519
  Aggregation Token: configured 0 , derived 2, remote 2
  Tx ULIA seq# 1, Rx ULIA seq# 1, Tx NHL seq# 1, Rx NHL seq# 2
  Remote node ID        72:160:47.00914455667722331011126 6.00603E7B2001.00
  Remote node address          47.009144556677223310111266.00603E7B2001.01
  Remote port ID         ATM0/0/3 (80003000) (0)
```

```
  Common peer group ID      56:47.0091.4455.6677.0000.0000.0000
  Upnode ID               56:72:47.00914455667722330000000.00603E7B2001.00
  Upnode Address                47.00914455667722331011266.00603E7B2001.02
  Upnode number: 11        Upnode Name: SanFran
NewYork.BldB.T3#
```

Configuring Aggregation Mode

You configure the aggregation mode for calculating metrics and attributes for aggregated PNNI links and nodes advertised to higher PNNI levels. The ATM switch router has two algorithms to perform link and node aggregation: best link and aggressive.

To configure link or node aggregation, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode and specify the local node you want to configure.
Step 3	Switch(config-pnni-node)# **aggregation-mode** {**link** | **node**} {**abr** | **cbr** | **ubr** | **vbr-rt** | **vbr-nrt** | **all**} {**best-link** | **aggressive**}	Configures the service category and aggregation mode for a link or a complex node.

Examples

The following example shows how to configure aggressive link aggregation mode for constant bit rate (CBR) traffic:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 2
Switch(config-pnni-node)# aggregation-mode link cbr aggressive
```

The following example shows how to configure best link aggregation mode for variable bit rate real time (VBR-RT) traffic on node 2:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 2
Switch(config-pnni-node)# aggregation-mode node vbr-rt best-link
```

Displaying the Aggregation Mode Configuration

To display the aggregation mode configuration, enter the following commands in EXEC mode:

Command	Purpose
show atm pnni aggregation link	Displays the link aggregation mode.
show atm pnni aggregation node	Displays the node aggregation mode.

Examples

The following example shows the link aggregation mode:

```
Switch# show atm pnni aggregation link

PNNI PGL link aggregation for local-node 2 (level=72, name=Switch.2.72)

  Configured aggregation modes (per service class):
     CBR         VBR-RT       VBR-NRT       ABR           UBR
  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~
  aggressive   best-link    best-link    best-link    best-link

 No Aggregated links for this node.
Switch#
```

The following example shows how to display the node aggregation mode:

```
Switch# show atm pnni aggregation node
PNNI nodal aggregation for local-node 2 (level=56, child PG level=60)
  Complex node representation, exception threshold: 60%

  Configured nodal aggregation modes (per service class):
    CBR          VBR-RT       VBR-NRT      ABR          UBR
  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~
  best-link    best-link    best-link    best-link    aggressive

Summary Complex Node Port List:
  Port ID  Rem Inn Agg-Token  Border Cnt In-Spoke  Out-Spoke Agg-Accur
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~~
  21FB000  12      0          1          default   default   ok
  2371000  13      0          1          default   default   ok

Summary Complex Node Bypass Pairs  List (exception bypass pairs only)
  /~~~~~~~~ LOWER PORT ID ~~~~~~~~\ /~~~~~~~~ HIGHER PORT ID ~~~~~~~\
  Port ID  Rem Inn Agg-Token  Inacc Port ID  Rem Inn Agg-Token  Inacc Exceptns
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~
  21FB000  12      0          no    2371000  13      0          no    fwd rev
```

Configuring Significant Change Thresholds

PNNI topology state elements (PTSEs) would overwhelm the network if they were transmitted every time any parameter in the network changed. To avoid this problem, PNNI uses significant change thresholds that control the origination of PTSEs.

Note Any change in administrative weight (AW) and cell loss ratio (CLR) is considered significant and triggers a new PTSE.

To configure the PTSE significant change threshold, take these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **ptse significant-change** {**acr-mt** *percent* | **acr-pm** *percent* | **cdv-pm** *percent* | **ctd-pm** *percent*}	Configures a PTSE significant change percentage.

For an example of other **ptse** command keywords, see Configuring PNNI Hello, Database Synchronization, and Flooding Parameters, page 11-49.

Example

The following example shows how to configure a PTSE being sent only if the available cell rate changes 30 percent from the current metric:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# ptse significant-change acr-pm 30
```

Displaying the Significant Change Thresholds Configuration

To display the PTSE configuration, use the following EXEC command:

Command	Purpose
show atm pnni resource-info	Displays the PTSE identifier.

Example

The following example shows the significant change threshold configuration using the **show atm pnni resource-info** EXEC command:

```
Switch# show atm pnni resource-info
PNNI:80.1 Insignificant change parameters
acr pm 50,  acr mt 3, cdv pm 25, ctd pm 50, resource poll interval 5 sec
Interface insignificant change bounds:
Interface ATM1/0/0
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
<information deleted>
```

Configuring the Complex Node Representation for LGNs

By default, higher-level logical group nodes (LGNs) represent their child peer groups (PGs) in the simple node representation. With simple node representation, the entire peer group is represented as a single node. When there are many nodes in the child peer group, you can use complex node representation to present a more accurate model of the PG. With complex node representation, the PG is represented by a nucleus, or center, and border ports.

For a detailed description of complex node representation and implementation guidelines, refer to the *Guide to ATM Technology*.

To configure complex node representation, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *local-node-index* Switch(config-pnni-node)#	Enters node configuration mode and specifies the local node you want to configure.
Step 3	Switch(config-pnni-node)# **nodal-representation** {**simple** | **complex** [**threshold** *threshold-value* | **radius-only**]}	Configures complex nodal representation and specifies how to handle exceptions.

Example

The following example shows how to configure a PNNI complex node:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 2
Switch(config-pnni-node)# nodal-representation complex
```

Displaying the PNNI Complex Node Configuration

To display the PNNI complex node configuration, perform the following task in privileged EXEC mode:

Command	Purpose
show atm pnni aggregation node	Displays the PNNI complex node configuration.

Example

The following example shows the PNNI complex node configuration:

```
Switch# show atm pnni aggregation node
PNNI nodal aggregation for local-node 2 (level=56, child PG level=60)
  Complex node representation, exception threshold: 60%

  Configured nodal aggregation modes (per service class):
    CBR          VBR-RT       VBR-NRT      ABR          UBR
  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~
  best-link    best-link    best-link    best-link    aggressive

Summary Complex Node Port List:
  Port ID  Rem Inn Agg-Token  Border Cnt In-Spoke  Out-Spoke Agg-Accur
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~~
  21FB000  12      0          1          default   default   ok
  2371000  13      0          1          default   default   ok

Summary Complex Node Bypass Pairs  List (exception bypass pairs only)
  /~~~~~~~~ LOWER PORT ID ~~~~~~~~\ /~~~~~~~~ HIGHER PORT ID ~~~~~~~\
  Port ID  Rem Inn Agg-Token  Inacc Port ID  Rem Inn Agg-Token  Inacc Exceptns
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~
  21FB000  12      0          no    2371000  13      0          no    fwd rev
```

Tuning Protocol Parameters

The tasks in the following subsections describe how to tune the PNNI protocol parameters that can affect the performance of your network.

Configuring PNNI Hello, Database Synchronization, and Flooding Parameters

PNNI uses the Hello protocol to determine the status of neighbor nodes and PNNI topology state elements (PTSEs) to disseminate topology database information in the ATM network.

To configure the Hello protocol parameters and PTSE significant change, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.

	Command	Purpose
Step 3	Switch(config-pnni-node)# **timer** [**ack-delay** *tenths-of-second*] [**hello-holddown** *tenths-of-second*] [**hello-interval** *seconds*] [**inactivity-factor** *number*] [**retransmit-interval** *seconds*]	Configures Hello database synchronization and flooding parameters.
Step 4	Switch(config-pnni-node)# **ptse** [**lifetime-factor** *percentage-factor*] [**min-ptse-interval** *tenths-of-second*] [**refresh-interval** *seconds*] [**request** *number*] [**significant-change acr-mt** *percent*] [**significant-change acr-pm** *percent*] [**significant-change cdv-pm** *percent*] [**significant-change ctd-pm** *percent*]	Configure PTSE significant change percent number.

Example

The following example shows how to configure the PTSE refresh interval to 600 seconds:

```
Switch(config-pnni-node)# ptse refresh-interval 600
```

The following example shows how to configure the retransmission of the Hello timer to 60 seconds:

```
Switch(config-pnni-node)# timer hello-interval 60
```

Displaying the PNNI Hello, Database Synchronization, and Flooding Configuration

To display the ATM PNNI Hello, database synchronization, and flooding configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI Hello, database synchronization, and flooding configuration.

Example

The following example shows the ATM PNNI Hello, database synchronization, and flooding configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
    Node Allows Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
    Redistributing static routes: Yes
```

Configuring the Resource Management Poll Interval

The resource management poll interval specifies how often PNNI polls resource management to update the values of link metrics and attributes. You can configure the resource poll interval to control the tradeoff between the processing load and the accuracy of PNNI information. A larger value usually generates a smaller number of PTSE updates. A smaller value results in greater accuracy in tracking resource information.

To configure the resource management poll interval, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **resource-poll-interval** *seconds*	Configures the resource management poll interval.

Example

The following example shows how to configure the resource management poll interval to 10 seconds:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# resource-poll-interval 10
```

Displaying the Resource Management Poll Interval Configuration

To display the resource management poll interval configuration, use the following EXEC command:

Command	Purpose
show atm pnni resource-info	Displays the resource management poll interval configuration.

Example

The following example shows the resource management poll interval configuration using the **show atm pnni resource-info** EXEC command:

```
Switch# show atm pnni resource-info
PNNI:80.1 Insignificant change parameters
acr pm 50,  acr mt 3, cdv pm 25, ctd pm 50, resource poll interval 5 sec
Interface insignificant change bounds:
Interface ATM1/0/0
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
Interface ATM1/0/3
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
<information deleted>
```

Configuring ATM PNNI Statistics Collection

You can collect the following statistics about the routing of ATM connections:

- Number of source route requests
- Number of micro-seconds spent in dijkstra algorithm
- Number of crankback source route requests
- Number of next port requests
- Number of background route lookups
- Number of on-demand route computations

To enable statistics collection, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **statistics call**	Enables ATM PNNI statistics gathering.

Example

The following example shows how to enable PNNI ATM statistics gathering:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# statistics call
```

Displaying ATM PNNI Statistics

To display the ATM PNNI statistics, use the following privileged EXEC command:

Command	Purpose
show atm pnni statistics call	Displays the ATM PNNI statistics.

Example

The following example shows the ATM PNNI statistics using the **show atm pnni statistics** privileged EXEC command:

```
Switch# show atm pnni statistics call

pnni call statistics since 22:19:29

                   total     cbr       rtvbr     nrtvbr    abr       ubr
source route reqs  1346      0         0         0         0         0
successful         1342      1342      0         0         0         0
unsuccessful       4         4         0         0         0         0
crankback reqs     0         0         0         0         0         0
successful         0         0         0         0         0         0
unsuccessful       0         0         0         0         0         0
on-demand attempts 0         0         0         0         0         0
successful         0         0         0         0         0         0
unsuccessful       0         0         0         0         0         0
background lookups 0         0         0         0         0         0
successful         0         0         0         0         0         0
unsuccessful       0         0         0         0         0         0
next port requests 0         0         0         0         0         0
successful         0         0         0         0         0         0
unsuccessful       0         0         0         0         0         0

                   total     average
usecs in queue     2513166   1867
usecs in dijkstra  0         0
usecs in routing   132703    98
```

Mobile PNNI Configuration

This section describes how to configure the mobile PNNI feature for networks linked by one or more wireless connections to a fixed ATM network. This features allows mobile PNNI networks to connect to the routing hierarchy of fixed PNNI networks or other mobile networks. Unlike fixed PNNI nodes, the attachment of point(s) of a mobile network change over time. This feature allows each mobile network to build its own PNNI hierarchy and integrate the hierarchy of the fixed network in the form of a logical group node. A logical group node has the capability to dynamically change its membership from one peer group to another as it moves in space and time. A mobile logical group node is only allowed to join a parent peer group of one of its current access point switches.

A border node of the mobile network may have one or more active mobile outside links to one or more access point switches. The border node uses one of the nodal hierarchy lists (NHL) received from the access point switches to build an outside nodal hierarchy list (ONHL) that contains a list of the host peer groups available at the access point switch. An outside nodal hierarchy list is then flooded by the source border node within the peer group and eventually reaches the peer group leader. In each peer group, and at all levels of the hierarchy of the mobile network, the peer group leader is responsible for choosing one outside nodal hierarchy list out of the several that have been advertised by the nodes of its peer group. The chosen outside nodal hierarchy list is then flooded at the next level of hierarchy by the associated logical group node. The final decision as to which host peer group to join, is made by the peer group leader of the highest level peer group in the given mobile network, the node that instantiates the mobile logical group node.

The mobile PNNI feature is not required to enable PNNI, but is provided to extend PNNI features to mobile networks.

Connecting Mobile PNNI Networks to Fixed PNNI Networks

The tasks in the following subsections describe how to connect mobile PNNI networks to fixed PNNI networks.

Configuring a Mobile PNNI Interface

The mobile link in a PNNI interface is a logical group node that advertises the Outside Nodal Hierarchy List (ONHL) based upon hello messages sent from outside networks.

To configure the mobile PNNI interface, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enter interface configuration mode.
Step 2	Switch(config-if)# **atm pnni mobile**	Specifies a mobile PNNI interface.

Example

The following example shows how to specify an interface as mobile:

```
Switch(config)# interface atm 0/0/1
Switch(config-atm-router)# atm pnni mobile
```

Configuring Mobile PNNI Nodes

A mobile PNNI node cannot have a parent node; it is therefore the highest node in the switching system once it is configured. To configure a PNNI node as mobile, perform these steps:

	Command	Purpose
Step 1	Switch# **configure terminal** Switch(config)#	Enters global configuration mode.
Step 2	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters PNNI configuration mode.
Step 3	Switch(config-atm-router)# **node** *node-number* **mobile**	Designates *node-umber* node as a mobile logical group node.

Examples

The following example shows how to designate node 3 within the switching system as a mobile logical group node:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 3 mobile
```

Displaying the Mobile PNNI Configuration Node

To display the mobile PNNI configuration node, use the following EXEC command:

Command	Purpose
show atm pnni node	Displays the PNNI node information, including mobility configuration

Example

The example below shows how to display PNNI node information.

```
Switch# show atm pnni node
PNNI node 1 is enabled and running
Node name: T3
System address 47.00914455667711441017332 2.00603E899901.01
Node ID 96:160:47.00914455667711441017332 2.00603E899901.00
Peer group ID 96:47.0091.4455.6677.1144.1017.3300
Level 96, Priority 60 110, No. of interfaces 2, No. of neighbors 1
Parent Node Index: 2
Node Allows Transit Calls
Node Representation: simple
Hello interval 15 sec, inactivity factor 5,
Hello hold-down 10 tenths of sec
Ack-delay 10 tenths of sec, retransmit interval 5 sec,
Resource poll interval 5 sec
SVCC integrity times: calling 35 sec, called 50 sec,
Horizontal Link inactivity time 120 sec,
PTSE refresh interval 1800 sec, lifetime factor 200 percent,
Min PTSE interval 10 tenths of sec
Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
Default administrative weight mode: uniform
Max admin weight percentage: -1
Next resource poll in 2 seconds
Max PTSEs requested per PTSE request packet: 32
Redistributing static routes: Yes
Max number of (internal) nodes in topology: 1032
PNNI node 2 is enabled and running
```

```
Node name: T3.2.72
System address 47.00914455667711441017332 2.00603E899901.02
Node ID 72:96:47.00914455667711441017330 0.00603E899901.00
Peer group ID 72:47.0091.3333.3333.3333.0000.0000
Level 72, Priority 0 0, No. of interfaces 0, No. of neighbors 1
Parent Node Index: NONE
Node Allows Transit Calls
Node Representation: simple
Hello interval 15 sec, inactivity factor 5,
Hello hold-down 10 tenths of sec
Ack-delay 10 tenths of sec, retransmit interval 5 sec,
Resource poll interval 5 sec
SVCC integrity times: calling 35 sec, called 50 sec,
Horizontal Link inactivity time 120 sec,
PTSE refresh interval 1800 sec, lifetime factor 200 percent,
Min PTSE interval 10 tenths of sec
Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
Default administrative weight mode: uniform
Max admin weight percentage: -1
Max PTSEs requested per PTSE request packet: 32
Redistributing static routes: No
Node is the mobile LGN. Highest join level: 0
Default PGID: 0:00.0000.0000.0000.0000.0000.0000
```

Displaying Mobile PNNI Operational Details

You can display the operational details of mobile PNNI at all levels in the switching system, including the lowest and logical node configuration.

To display the mobile PNNI information, use the following privileged EXEC or EXEC command:

Command	Purpose
show atm pnni mobility-info	Displays mobile PNNI operational details.

Example

The following example shows how to display mobile PNNI information using the **show atm pnni mobility-info** command:

```
Switch# show atm pnni mobility-info
Local Mobile Interface(s):
Local Port SS Remote Potential source of ONHL
~~~~~~~~~~~~~ ~~ ~~~~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~
ATM0/1/0 -- n/a No, Not a mobile interface
ATM0/1/2 3 Mobile Yes, Sources ONHL
Lowest Node 1 Mobility Information:
Mobile LGN joined ind rcvd: Yes
Mobile LGN's child PGL inn: 1
Mobile LGN's joined PG ID : 72:47.0091.3333.3333.3333.0000.0000

Logical Node 1 Mobility Information:
Leader/Mobile LGN Status : PGL
Node is Mobile LGN's child: Yes
Parent Mobile LGN joined? : Yes
Parent Mobile LGN host PG : 72:47.0091.3333.3333.3333.0000.0000
Passing up ONHL from node : 1

Logical Node 2 Mobility Information:
Leader/Mobile LGN Status : Mobile LGN
```

```
Cfgd highest join level : 0 (default)
Cfgd default peer group ID: Not configured
Mobile LGN host PG joined?: Yes
Mobile LGN's joined PG ID : 72:47.0091.3333.3333.3333.0000.0000
```

Configuring a Limit for the ONHL

You can optionally specify the highest PNNI hierarchy level to be advertised in the NHL. A mobile network cannot see higher than the highest level advertised in the NHL and is therefore prevented from connecting at levels higher than those advertised by the fixed network. This feature can offer protection from poorly configured mobile networks.

To configure the highest hierarchy level for the ONHL, perform these steps, beginning in the configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Enters ATM configuration mode.
Step 2	Switch(config-atm-router)# **atm pnni nodal-hierarchy-list highest-level** *level*	Specifies highest level in PNNI hierarchy to advertise in the NHL.

Example

The following example shows how to configure the highest advertised PNNI level in the ONHL:

```
Switch(config)# atm interface 0/0/1
Switch(config-if)# atm pnni nodal-hierarchy-list highest-level 48
```

PNNI Connection Trace

The PNNI connection trace function provides information about switches and links traversed by a specified connection through a PNNI network. A trace connection traces existing switched connections that have been established through normal signaling procedures. Depending upon the options specified when initiating the trace, you get the following connection details:

- The node ID of each node
- One port ID for each node (except endpoints)
- Both port IDs for endpoints
- The virtual path identifier (VPI) and virtual channel identifier (VCI) value on each link
- The call-reference value on each link
- The end-point reference value on each link for point-to-multipoint connections

A trace connection can be initiated from any switch that a connection or party traverses, as long as the switch is running PNNI. The connection or party may be going beyond the PNNI network (for example, through a public ATM network), but the trace connection only collects information only from switches within the PNNI network. Starting from an interface on a switch, the trace connection proceeds in one direction, and the connection or party is traced in only this direction.

A connection can be traced in any direction, regardless of the direction in which the call was established. A trace connection is accomplished using two new signaling messages: Trace-Connection (TC) and Trace-Connection-Acknowledgment (TCAck). Both types of messages contain the Trace-Transit-List

(TTL) information element (IE). When a trace connection is triggered, the trace source node originates a trace connection message. This message contains the TTL IE. Each switch receiving this message appends its own connection information to the TTL IE and forwards it to the next connection on the interface; consequently, the IE increases in size as the trace progresses through the network. The data in the IEs also determine if the trace is performed for VPI/VCI values or call-reference values or both. The trace stops at the destination switch. The trace destination switch prepares a TCAck message containing all trace information in its TTL IE and sends it back to the source switch. Each switch along the trace simply forwards the TCAck message back to the source without any further processing. The trace connection is complete when the source switch receives the TCAck message. The source switch extracts the information from the TTL IE and stores it. For point-to-multipoint connections, a connection trace works for only one party at a time—each party needs to be traced separately.

The trace source switch maintains the results of each trace for the duration specified by its *age-timeout* parameter. The default for this parameter is 10 minutes. However, if the connection or party that was traced gets cleared, then all trace information associated with that connection or party is deleted, regardless of the *age-timeout* parameter.

For a trace connection to work perfectly, all switches in the path of the connection or party being traced should support trace connection, or in other words, the switches should understand TC and TCAck messages. Even if some intermediate switches do not support these messages, partial trace information can be obtained if they support pass-along of signaling messages. If intermediate switches do not support pass-along, then trace connections are not successful.

A trace connection is supported for both point-to-point and point-to-multipoint connections, and is used on the following types of connections:

- SVPs
- SVCs
- Soft VCs
- Soft VPs
- Frame-relay Soft VC

Note The connection trace function is not supported on for point-to-multipoint soft PVC connections.

Initiating a Connection Trace

To initiate a trace connection, first a switch must be selected. On this switch, the trace connection can be initiated in the following ways:

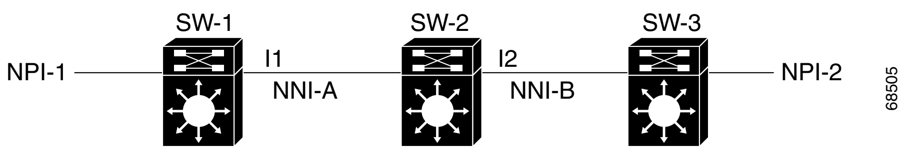
- From an ATM interface by specifying:
  - The VPI-VCI of an SVC or a soft-VC
  - The VPI of an SVP or a soft-VP
  - The VPI-VCI and the endpoint-reference for a party of a point-to-multipoint connection.
  - The call-reference value of an SVC or an SVP
  - The call-reference and endpoint-reference for a party of a P2MP connection.
- From a serial (Frame Relay) interface by specifying:
  - The DLCI value, such that there is a Frame Relay soft-VC associated with this DLCI. The associated soft-VC is traced.

Note It is not possible to initiate traces from CES interfaces.

Figure 11-2 shows an SVC transiting switches 1, 2, and 3. This could happen when NPI-1 and NPI-2 are ATM UNI interfaces connecting the switches to routers. When a trace is initiated on this SVC from interface I1 of SW-1, in a direction going out from the switch, then the following information is obtained in the trace.

Note In this section, *incoming* refers to an interface through which the TC message enters the switch and *outgoing* refers to the interface through which the TC message leaves the switch, or the trace-destination-interface.

Figure 11-2 SVC with Connection Trace Initiated from I1 on Switch 1



In Figure 11-2, the following information is obtained from the trace:

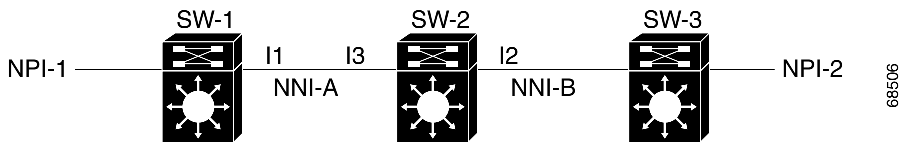
- Switch 1
  - Outgoing Interface I1
- Switch 2
  - Outgoing Interface I2
- Switch 3
  - Outgoing Interface NPI-2

If the option to collect VPI or VCI information is specified for the example in Figure 11-2, the following information is obtained from the trace connection:

- Switch 1
  - Outgoing: Interface I1
- Switch 2
  - Incoming: VPI value on NNI-A; VCI value on NNI-A
  - Outgoing: Interface I2
- Switch 3
  - Incoming: VPI value on NNI-B; VCI value on NNI-B
  - Outgoing: VPI value on NPI-2; VCI value on NPI-2; zero port-ID for non-PNNI interface; interface NPI-2.

If however, the trace is initiated from interface I2 on switch 2, different results are obtained, depending on the direction in which the trace is initiated. Figure 11-3 shows the same SVC as Figure 11-2, but with the trace initiated from I2 on switch 2.

Figure 11-3 SVC with Connection Trace Initiated from I2 on Switch 2



If the direction of the trace is chosen as outgoing from switch 2, the trace returns the following information:

- Switch 2
  - Outgoing: Interface I2
- Switch 3
  - Incoming: VPI value on NNI-B; VCI value on NNI-B
  - Outgoing: VPI value on NPI-2; VCI value on NPI-2; zero port-ID for non-PNNI interface; interface NPI-2

If, however, the direction on interface I2 is chosen as incoming into switch 2, the trace proceeds in the reverse direction. In this case, the trace returns the following information:

- Switch 2
  - Incoming: VPI value on NNI-B; VCI value on NNI-B
  - Outgoing: Interface I3
- Switch 1
  - Incoming: VPI value on NNI-A; VCI value on NNI-A
  - Outgoing: VPI value on NPI-1; VCI value on NPI-1; zero port-ID for non-PNNI interface; interface NPI-1

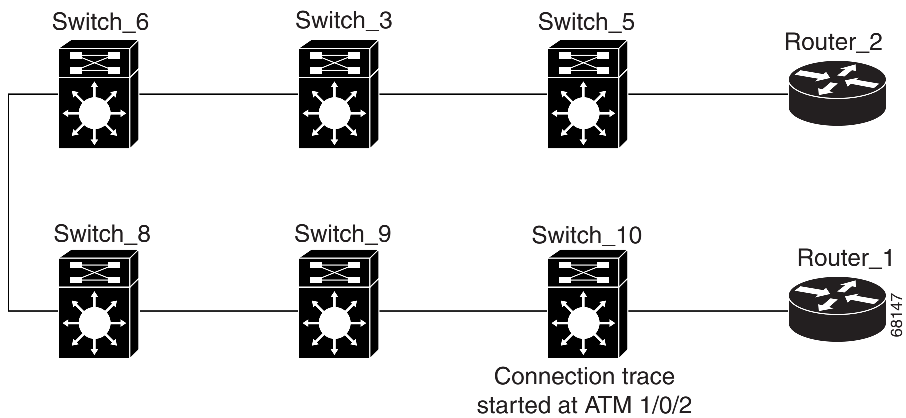
To initiate a trace connection on a PNNI interface connection, use one of the following commands in EXEC configuration mode:

Command	Purpose
atm pnni trace connection interfaces atm *slot/subslot/port* {**direction** {**incoming** | **outgoing**} {**call-reference** *value* [**endpt-reference** *value*] | {**vpi** *vpi* [**vci** *vci*]} [**endpt-reference** *value*]} [**age-timeout** {*seconds* | **none**}] [**call-reference-trace**] [**connection-id-trace**] [**fail-timeout** *seconds*] [**no-pass-along**]	Configures ATM PNNI connection trace.
atm pnni trace connection interfaces serial *card/subcard/port***:***cgn* **dlci** *number* [**age-timeout** {*seconds* | **none**}] [**call-reference-trace**] [**connection-id-trace**] [**fail-timeout** *seconds*] [**no-pass-along**]	Configures Frame Relay PNNI connection trace.

Example

Figure 11-4 is an example of an ATM PNNI network used to display the trace connection initialization.

Figure 11-4 PNNI Connection Trace Network Example



The following example initiates a trace connection on an ATM interface:

```
Switch_10# atm pnni trace connection interface ATM 1/0/2 direction incoming vpi 0 vci 136
endpt-reference 6 call-reference-trace connection-id-trace age-timeout none

Request accepted - request index: 20
Switch_10#
```

Note You can use the request index number displayed in the configuration message to display the specific connection trace for this interface.

If the request is not accepted, an error message similar to one of the following appears:

```
%Request not accepted: 5 requests already active
%Request not accepted: Max (100) requests already stored
%Request not accepted: Invalid parameter values
```

Displaying the Connection Trace Output

This section describes how to display PNNI connection trace output information.

To display the PNNI connection trace output, use the following command:

Command	Purpose
show atm pnni trace connection {**all** | *index-number* [**detail** | **summary**]} [**hex-only**]	Displays the PNNI connection trace output.

Examples

The following example shows an active PNNI connection trace summary for the connections shown in Figure 11-4:

```
Switch_10# show atm pnni trace connection 20
                Connection Trace Request-index: 20
Connection Type:  ATM-VC
Source Interface: ATM1/0/2               Direction:           Incoming
VPI:              0                      Call-Reference:      Not specified
VCI:              136                    Endpoint-Reference:  0x6
Time to age:      490 seconds
Trace Flags:      Connection-Id, Call-Reference
Pass Along:       Requested
Trace Result:     Trace Completed Normally

                                                  Node    Outgoing-port
                                                  ~~~~    ~~~~~~~~~~~~~
                                             Switch_10    ATM1/0/1
                                             Switch_09    ATM1/0/3
                                             Switch_08    ATM1/0/0
                                             Switch_06    ATM3/0/1
                                             Switch_03    ATM1/1/0
                                             Switch_05    0x0
Switch_10#
```

Note The Trace Result field indicates whether the trace completed normally or not.

Note The switch names listed under the Node heading indicate the nodes the connection trace traversed.

Note The Outgoing-port heading indicates the outgoing port of each node.

The following example displays the nodes and outgoing ports in hexadecimal mode for the specified index number variable for the connections shown in Figure 11-4:

```
Switch_10# show atm pnni trace connection 20 hex-only
                Connection Trace Request-index: 20
Connection Type:  ATM-VC
Source Interface: ATM1/0/2               Direction:           Incoming
VPI:              0                      Call-Reference:      Not specified
VCI:              136                    Endpoint-Reference:  0x6
Time to age:      490 seconds
Trace Flags:      Connection-Id, Call-Reference
Pass Along:       Requested
Trace Result:     Trace Completed Normally

                                                  Node    Outgoing-port
                                                  ~~~~    ~~~~~~~~~~~~~
   56:160:47.00918100000000050E2097801.0060705BC701.00    0x80801000
   56:160:47.009181000000004DDECD401.0004DDECD401.00    0x80803000
   56:160:47.00918100000000D0BA34E001.00D0BA34E001.00    0x80800000
   56:160:47.009181000000004DDECD301.0004DDECD301.00    0x81801000
   56:160:47.00918100000000036B5A4901.00036B5A4901.00    0x80900000
   56:160:47.00918100000001007461301.001007461301.00    0x0
Switch_10#
```

Note The **hex-only** keyword indicates the nodes the connection trace traversed and the interface numbers of the outgoing port in hexadecimal mode.

Note The PNNI address listed under the Node heading indicates the nodes the connection trace traversed.

Note The hexadecimal numbers under the Outgoing-port heading indicate the outgoing port of each node.

The following example displays more detailed output for an active PNNI connection trace by specifying the **detail** keyword for the connections shown in Figure 11-4:

```
Switch_10# show atm pnni trace connection 20 detail
                Connection Trace Request-index: 20
Connection Type:  ATM-VC
Source Interface: ATM1/0/2                Direction:          Incoming
VPI:              0                       Call-Reference:     Not specified
VCI:              136                     Endpoint-Reference: 0x6
Time to age:      490 seconds
Trace Flags:      Connection-Id, Call-Reference
Pass Along:       Requested
Trace Result:     Trace Completed Normally

Node: Switch_10
 [Incoming] VPI: 0     VCI: 136    Call-Ref: 0x800003  Endpt-Ref: 0x6
 [Outgoing] Port: ATM1/0/1

Node: Switch_09
 [Incoming] VPI: 0     VCI: 384    Call-Ref: 0x800003  Endpt-Ref: 0x6
 [Outgoing] Port: ATM1/0/3

Node: Switch_08
 [Incoming] VPI: 0     VCI: 138    Call-Ref: 0x800004  Endpt-Ref: 0x6
 [Outgoing] Port: ATM1/0/0

Node: Switch_06
 [Incoming] VPI: 0     VCI: 38     Call-Ref: 0x800004  Endpt-Ref: 0x6
 [Outgoing] Port: ATM3/0/1

Node: Switch_03
 [Incoming] VPI: 0     VCI: 40     Call-Ref: 0x800004  Endpt-Ref: 0x6
 [Outgoing] Port: ATM1/1/0

Node: Switch_05
 [Incoming] VPI: 0     VCI: 41     Call-Ref: 0x800004  Endpt-Ref: 0x6
 [Outgoing] Port: 0x0
            VPI: 0     VCI: 53     Call-Ref: 0xF       Endpt-Ref: 0x6
Switch_10#
```

Note The Trace Result field indicates whether the trace completed normally or not.

Note The Incoming and Outgoing VPI and VCI numbers provide the VCs for each node in the connection trace.

Displaying PNNI Connection Trace Configuration

This section describes how to display active PNNI connection trace configuration.

To display the active PNNI connection trace configuration, use the following command:

Command	Purpose
show atm pnni trace info	Displays the PNNI connection trace configuration.

Example

The following example shows an active PNNI connection trace configuration:

```
Switch_10# show atm pnni trace information
Max TTL Size:             1466 bytes
Accepted Requests:        1      ActiveRequests:          0
Max Acceptable Requests: 100    Max Concurrent Requests: 5
Boundary Interfaces:
                     None
Switch_10#
```

Note The Accepted Requests field should indicate a number less than the maximum of 100 connections.

Note The Active Requests field should indicate some number less than the maximum concurrent requests of 5.

Note Trace records for both switched and soft-VC calls are deleted *automatically* when that call is cleared. If, for any reason, a soft VC is torn down, all existing trace records configured for that soft VC are deleted. These records are deleted irrespective of the age-timer value. This deletion occurs even if the connection is reconfigured again.

Deleting Connection Trace Requests

This section describes how to remove a connection trace request and its results. The system can accommodate only100 trace connection records. When this limit is reached, you must clear old trace requests and their information before initiating new connection traces.

To delete PNNI connection trace information and results that are stored in system VRAM, use the following command in the privileged EXEC mode:

Command	Purpose
clear atm pnni trace connection	Deletes the PNNI connection trace output stored in VRAM.

Note You can modify the maximum number of concurrent PNNI connection traces by using the **atm pnni trace max-concurrent** global configuration command. The range is 1 to 100.

Note You can modify the maximum size of the PNNI trace transit list (TTL) information elements (IEs) by using the **atm pnni trace transit-list max-size** global configuration command. Its default max size (1466 bytes) can hold trace information for 35 to 45 nodes, depending on the trace options used. If a single call traverses more than 45 nodes in a PNNI network, use this command to increase the size of the TTL IE to accommodate all the trace information.To revert to the default value, use the **no** form of the command.

Examples

The following example displays the **clear atm pnni trace connection all** command to delete all of the active and accepted PNNI connection traces:

```
Switch# clear atm pnni trace connection all
```

The following example displays the **clear pnni trace connection delete** command with the index number to delete a specific PNNI connection trace.

```
Switch# clear atm pnni trace connection 100
```

Designating PNNI Trace Boundaries

This section describes how to create PNNI trace boundaries. If a trace enters the switch at a boundary interface, it is incomplete. If a trace terminates at a boundary interface, it is successful. Any ATM interface can be configured as a trace boundary, however, it is only meaningful for PNNI interfaces.

To designate an ATM interface as a PNNI connection trace boundary, use the following command in the privileged EXEC mode:

Command	Purpose
atm pnni trace boundary	Designates an ATM interface as a PNNI connection trace boundary.

Note All non-ATM interfaces are not boundary interfaces by default.

Example

The following example shows how to configure an ATM interface as a PNNI connection trace boundary:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm pnni trace boundary
```

Using Access Control

This chapter describes how to configure and maintain access control lists, which are used to permit or deny incoming calls or outgoing calls on an interface of the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Access Control Overview

The ATM signalling software uses the access control list to filter setup messages on an interface based on destination, source, or a combination of both. Access lists can be used to deny connections known to be security risks and permit all other connections, or to permit only those connections considered acceptable and deny all the rest. For firewall implementation, denying access to security risks offers more control.

During initial configuration, perform the following steps to use access control to filter setup messages:

Step 1 Create a template alias allowing you to use real names instead of ATM addresses in your ATM filter expressions.

Step 2 Create the ATM filter set or filter expression based on your requirements.

Step 3 Associate the filter set or filter expression to an interface using the atm **atm access-group** command.

Step 4 Confirm the configuration.

Configuring a Template Alias

To configure an ATM template alias, use the following command in global configuration mode:

Command	Purpose
atm template-alias *name template*	Configures a global ATM address template alias.

Examples

The following example creates a template alias named *training* using the ATM address template 47.1328 and the ellipses (...) to fill in the trailing 4-bit hexadecimal digits in the address:

```
Switch(config)# atm template-alias training 47.1328...
```

The following example creates a template alias named *bit_set* with the ATM address template 47.9f9.(1*0*).88ab... that matches the four addresses that begin with the following:

- 47.9F9(1*000*).88AB... = 47.9F9*8*.88AB...
- 47.9F9(1*001*).88AB... = 47.9F9*9*.88AB...
- 47.9F9(1*100*).88AB... = 47.9F9*C*.88AB...
- 47.9F9(1*101*).88AB... = 47.9F9*D*.88AB...

```
Switch(config)# atm template-alias bit_set 47.9f9(1*0*).88ab...
```

The following example creates a template alias named *byte_wise* with the ATM address template 47.9*F8.33... that matches all ATM addresses beginning with the following sixteen prefixes:

- 47.9*0*F8.33...

  through

- 47.9*F*F8.33...

```
Switch(config)# atm template-alias byte_wise 47.9*F8.33...
```

Displaying the Template Alias Configuration

To display template alias configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the current configuration.

Example

The following example shows the template aliases configured in the previous examples using the **more system:running-config** privileged EXEC command:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
!
username dtate
ip rcmd remote-username dplatz
atm template-alias training 47.1328...
atm template-alias bit_set 47.9f9(1*0*).88ab...
atm template-alias byte_wise 47.9*f8.33...
!
<information deleted>
```

Configuring ATM Filter Sets

To create an ATM address filter or time-of-day filter, use the following command in global configuration mode:

Command	Purpose
atm filter-set *name* [**index** *number*] [**permit** | **deny**] {*template* | **time-of-day** {**anytime** | *start-time end-time*}}	Configures a global ATM address filter set.

Examples

The following example creates a filter named *filter_1* that permits access to the specific ATM address 47.0000.8100.1234.0003.c386.b301.0003.c386.b301.00:

```
Switch(config)# atm filter-set filter_1 permit
47.0000.8100.1234.0003.c386.b301.0003.c386.b301.00
```

The following example creates a filter named *filter_2* that denies access to the specific ATM address 47.000.8100.5678.0003.c386.b301.0003.c386.b301.00, but allows access to all other ATM addresses:

```
Switch(config)# atm filter-set filter_2 deny
47.0000.8100.5678.0003.c386.b301.0003.c386.b301.00
Switch(config)# atm filter-set filter_2 permit default
```

The following example creates a filter named *filter_3* that denies access to all ATM addresses that begin with the prefix 47.840F, but permits all other calls:

```
Switch(config)# atm filter-set filter_3 deny 47.840F...
Switch(config)# atm filter-set filter_3 permit default
```

Note The order in which deny and permit filters are configured is very important. See the following example.

In the following example, the first filter set, *filter_4*, has its first filter configured to permit all addresses and its second filter configured to deny access to all addressees that begin with the prefix 47.840F. Since the default filter matches all addresses, the second filter is never used. Addresses that begin with prefix 47.840F are also permitted.

```
Switch(config)# atm filter-set filter_4 permit default
Switch(config)# atm filter-set filter_4 deny 47.840F...
```

The following example creates a filter named *filter_5* that denies access to all ATM addresses described by the ATM template alias bad_users:

```
Switch(config)# atm filter-set filter_5 deny bad_users
Switch(config)# atm filter-set filter_5 permit default
```

The following example shows how to configure a filter set named *tod1*, with an index of 2, to deny calls between 11:15 a.m. and 10:45 p.m.:

```
Switch(config)# atm filter-set tod1 index 2 deny time-of-day 11:15 22:45
Switch(config)# atm filter-set tod1 index 3 permit time-of-day anytime
```

The following example shows how to configure a filter set named *tod1*, with an index of 4, to permit calls any time:

```
Switch(config)# atm filter-set tod1 index 4 permit time-of-day anytime
```

The following example shows how to configure a filter set named *tod2* to deny calls between 8:00 p.m. and 6:00 a.m.:

```
Switch(config)# atm filter-set tod2 deny time-of-day 20:00 06:00
Switch(config)# atm filter-set tod2 permit time-of-day anytime
```

The following example shows how to configure a filter set named *tod2* to permit calls at any time:

```
Switch(config)# atm filter-set tod2 permit time-of-day 3:30 3:30
```

Once you create a filter set using the previous configuration commands, it must be associated with an interface as an access group to actually filter any calls. See Configuring ATM Interface Access Control to configure an individual interface with an access group.

Deleting Filter Sets

To delete an ATM filter set, use the following command in global configuration mode:

Command	Purpose
no atm filter-set *name* [**index** *number*]	Deletes a global ATM address filter set.

Example

The following example shows how to display and delete filter sets:

```
Switch# show atm filter-set
ATM filter set tod1
  deny From 11:15 Hrs Till 22:45 Hrs  index 2
  permit From 0:0 Hrs Till 0:0 Hrs  index 4
ATM filter set tod2
  deny From 20:0 Hrs Till 6:0 Hrs  index 1
  permit From 3:30 Hrs Till 3:30 Hrs  index 2
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# no atm filter-set tod1 index 2
Switch(config)# no atm filter-set tod2
Switch(config)# end
Switch#
%SYS-5-CONFIG_I: Configured from console by console
Switch# show atm filter-set
ATM filter set tod1
  permit From 0:0 Hrs Till 0:0 Hrs  index 4
```

Configuring an ATM Filter Expression

To create global ATM filter expressions, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm filter-expr** *name term*	Defines a simple filter expression with only one term and no operators.
Step 2	Switch(config)# **atm filter-expr** *name* [**destination** | **source** | **src**] *term1* **and** [**destination** | **source** | **src**] *term2*	Defines a filter expression using the operator **and**.
Step 3	Switch(config)# **atm filter-expr** *name* **not** [**destination** | **source** | **src**] *term*	Defines a filter expression using the operator **not**.
Step 4	Switch(config)# **atm filter-expr** *name* [**destination** | **source** | **src**] *term1* **or** [**destination** | **source** | **src**] *term2*	Defines a filter expression using the operator **or**.
Step 5	Switch(config)# **atm filter-expr** *name* [**destination** | **source** | **src**] *term1* **xor** [**destination** | **source** | **src**] *term2*	Defines a filter expression using the operator **xor**.
Step 6	Switch(config)# **no atm filter-expr** *name*	Deletes a filter.

Examples

The following example defines a simple filter expression that has only one term and no operators:

```
Switch(config)# atm filter-expr training filter_1
```

The following example defines a filter expression using the operator **not**:

```
Switch(config)# atm filter-expr training not filter_1
```

The following example defines a filter expression using the operator **or**:

```
Switch(config)# atm filter-expr training filter_2 or filter_1
```

The following example defines a filter expression using the operator **and**:

```
Switch(config)# atm filter-expr training filter_1 and source filter_2
```

The following example defines a filter expression using the operator **xor**:

```
Switch(config)# atm filter-expr training filter_2 xor filter_1
```

Configuring ATM Interface Access Control

To subscribe an ATM interface or subinterface to an existing ATM filter set or filter expression, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Selects the interface or subinterface to be configured.
Step 2	Switch(config-if)# **atm access-group** *name* [**in** | **out**]	Configures an existing ATM address pattern matching the filter expression.

Examples

The following example shows how to configure access control for outgoing calls on ATM interface 3/0/0:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm access-group training out
```

The following example shows how to configure access control for both outgoing and incoming calls on ATM interface 3/0/0:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm access-group training out
Switch(config-if)# atm access-group marketing in
```

Displaying ATM Filter Configuration

To display access control configuration, use the following EXEC commands:

Command	Purpose
show atm filter-set [*name*]	Displays a specific or a summary of ATM filter set.
show atm filter-expr [**detail**] *name*	Displays a specific or a summary of ATM filter expression.

Examples

The following command displays the configured ATM filters:

```
Switch# show atm filter-set
ATM filter set tod1
  deny From 11:15 Hrs Till 22:45 Hrs  index 2
  permit From 0:0 Hrs Till 0:0 Hrs  index 4
ATM filter set tod2
  deny From 20:0 Hrs Till 6:0 Hrs  index 1
  permit From 3:30 Hrs Till 3:30 Hrs  index 2
```

The following command displays the configured ATM filter expressions:

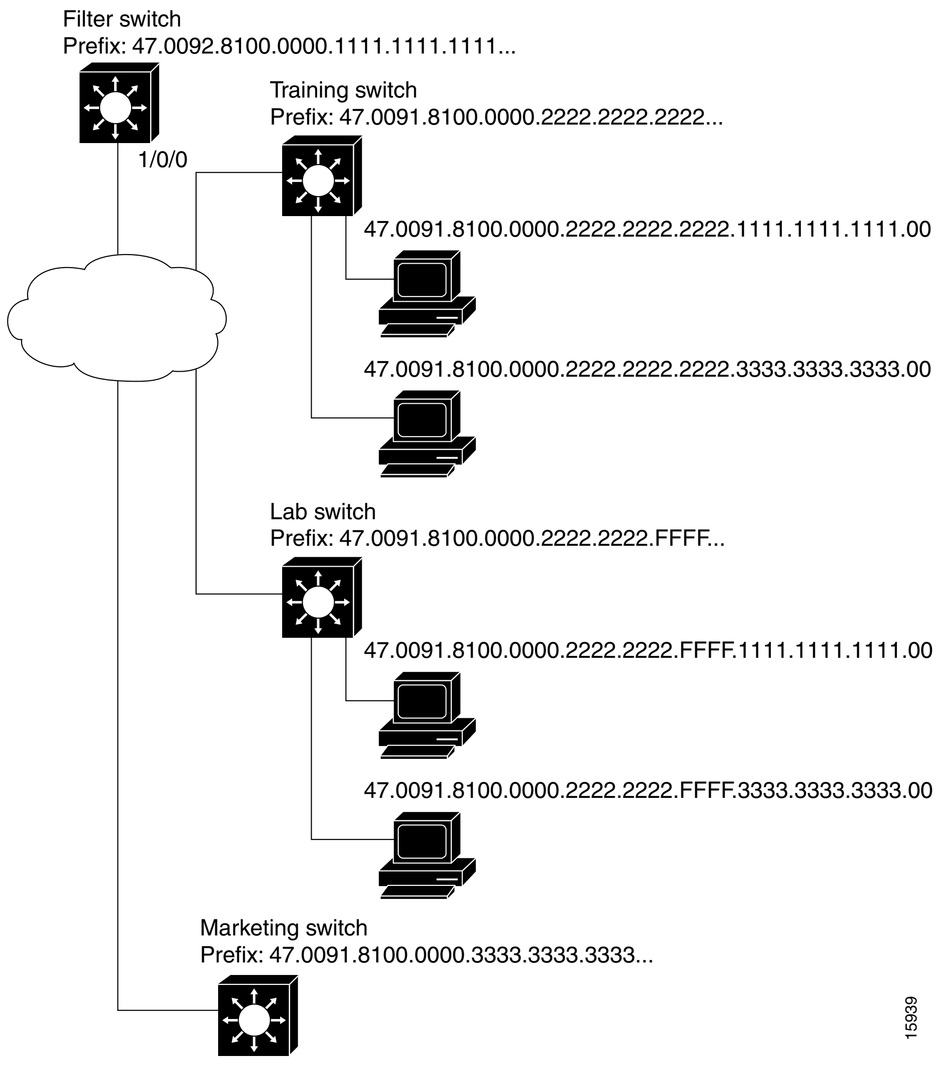
```
Switch# show atm filter-expr
training = dest filter_1
```

ATM Filter Configuration Scenario

This section provides a complete access filter configuration example using the information described in the preceding sections.

The example network configuration used in the following filter set configuration scenario is shown in Figure 12-1.

Figure 12-1 ATM Access Filter Configuration Example



Example

The following example shows how to configure the Filter Switch, shown in Figure 12-1, to deny access to all calls received on ATM interface 1/0/0 from the workstations directly attached to the Lab Switch, but to allow all other calls. The Filter Switch denies all calls if the calling party address begins with the prefix 47.0091.8100.0000.2222.2222.FFFF:

```
Filter Switch(config)# atm template-alias lab-sw 47.0091.8100.0000.2222.2222.FFFF...
Filter Switch(config)# atm filter-set filter_1 deny lab-sw
```

```
Filter Switch(config)# atm filter-set filter_1 permit default
Filter Switch(config)# atm filter-expr exp1 src filter_1
Filter Switch(config)#
Filter Switch(config)# interface atm 1/0/0
Filter Switch(config-if)# atm access-group exp1 in
Filter Switch(config-if)# end
Filter Switch# show atm filter-set
ATM filter set filter_1
  deny   47.0091.8100.0000.2222.2222.ffff...  index 1
  permit default  index 2
Filter Switch# show atm filter-expr
exp1 = src filter_1
```

Filtering IP Packets at the IP Interfaces

IP packet filtering helps control packet movement through the network. Such control can help limit network traffic and restrict network use by certain users or devices. To permit or deny packets from crossing specified IP interfaces, Cisco provides access lists.

You can use access lists for the following reasons:

- Control the transmission of packets on an IP interface
- Control virtual terminal line access
- Restrict contents of routing updates

This section summarizes how to create IP access lists and how to apply them.

Note This section applies to the IP interfaces only.

An access list is a sequential collection of permit and deny conditions that apply to IP addresses. The ATM switch router software tests addresses against the conditions in an access list one by one. The first match determines whether the software accepts or rejects the address. Because the software stops testing conditions after the first match, the order of the conditions is critical. If no conditions match, the software rejects the address.

The two steps involved in using access lists follow:

Step 1 Create an access list by specifying an access list number and access conditions.

Step 2 Apply the access list to interfaces or terminal lines.

These steps are described in the following sections:

- "Creating Standard and Extended IP Access Lists" section on page 12-9
- "Applying an IP Access List to an Interface or Terminal Line" section on page 12-11

Creating Standard and Extended IP Access Lists

The ATM switch router software supports three styles of access lists for IP interfaces:

- Standard IP access lists use source addresses for matching operations.

- Extended IP access lists use source and destination addresses for matching operations, as well as optional protocol type information for increased control.
- Dynamic extended IP access lists grant access per user to a specific source or destination host through a user authentication process. In essence, you can allow user access through a firewall dynamically, without compromising security restrictions.

To create a standard access list, use one of the following commands in global configuration mode:

Command	Purpose
access-list *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*]	Defines a standard IP access list using a source address and wildcard.
access-list *access-list-number* {**deny** | **permit**} **any**	Defines a standard IP access list using an abbreviation for the source and source mask of 0.0.0.0 255.255.255.255.

To create an extended access list, use one of the following commands in global configuration mode:

Command	Purpose
access-list *access-list-number* {**deny** | **permit**} *protocol source source-wildcard destination destination-wildcard* [**precedence** *precedence*] [**tos** *tos*] [**established**] [**log**]	Defines an extended IP access list number and the access conditions. Use the **log** keyword to get access list logging messages, including violations.
access-list *access-list-number* {**deny** | **permit**} *protocol* **any**	Defines an extended IP access list using an abbreviation for a source and source wildcard of 0.0.0.0 255.255.255.255, and an abbreviation for a destination and destination wildcard of 0.0.0.0 255.255.255.255.
access-list *access-list-number* {**deny** | **permit**} *protocol* **host** *source* **host** *destination*	Defines an extended IP access list using an abbreviation for a source and source wildcard of *source* 0.0.0.0, and an abbreviation for a destination and destination wildcard of *destination* 0.0.0.0.
access-list *access-list-number* **dynamic** *dynamic-name* [**timeout** *minutes*] {**deny** | **permit**} *protocol source source-wildcard destination destination-wildcard* [**precedence** *precedence*] [**tos** *tos*] [**established**] [**log**]	Defines a dynamic access list.

After you create an access list, any subsequent additions (possibly entered from the terminal) are placed at the end of the list. In other words, you cannot selectively add or remove access list command lines from a specific access list.

Note When making the standard and extended access list, by default, the end of the access list contains an implicit deny statement for everything if it does not find a match before reaching the end. Further, with standard access lists, if you omit the mask from an associated IP host address access list specification, 0.0.0.0 is assumed to be the mask.

Applying an IP Access List to an Interface or Terminal Line

After you create an access list, you can apply it to one or more interfaces. Access lists can be applied on *either* outbound or inbound interfaces. The following two tables show how this task is accomplished for both terminal lines and network interfaces.

To apply an access list to a terminal line, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **line** [**aux** | **console** | **vty**] *line-number* Switch(config-line)#	Selects the line to be configured.
Step 2	Switch(config-line)# **access-class** *access-list-number* {**in** | **out**}	Restricts incoming and outgoing connections between a particular virtual terminal line (into a device) and the addresses in an access list.

To apply an access list to a network interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface or subinterface to be configured.
Step 2	Switch(config-if)# **ip access-group** *access-list-number* {**in** | **out**}	Controls access to an interface.

For inbound access lists, after receiving a packet, the ATM switch router software checks the source address of the packet against the access list. If the access list permits the address, the software continues to process the packet. If the access list rejects the address, the software discards the packet and returns an Internet Control Message Protocol (ICMP) host unreachable message.

For outbound access lists, after receiving and routing a packet to a controlled interface, the software checks the source address of the packet against the access list. If the access list permits the address, the software transmits the packet. If the access list rejects the address, the software discards the packet and returns an ICMP host unreachable message.

If you apply an access list (standard or extended) that has not yet been defined to an interface, the software acts as if the access list has not been applied to the interface and accepts all packets. You must define the access list to the interface if you use it as a means of security in your network.

Note Set identical restrictions on all the virtual terminal lines, because a user can attempt to connect to any of them.

IP Access List Examples

In the following example, network 36.0.0.0 is a Class A network whose second octet specifies a subnet; that is, its subnet mask is 255.255.0.0. The third and fourth octets of a network 36.0.0.0 address specify a particular host.

Using access list 2, the ATM switch router software accepts one address on subnet 48 and rejects all others on that subnet. The last line of the list shows that the software accepts addresses on all other network 36.0.0.0 subnets.

```
Switch(config)# access-list 2 permit 36.48.0.3
Switch(config)# access-list 2 deny 36.48.0.0 0.0.255.255
Switch(config)# access-list 2 permit 36.0.0.0  0.255.255.255
Switch(config)# interface ethernet0
Switch(config-if)# ip access-group 2 in
```

Examples of Implicit Masks in IP Access Lists

IP access lists contain *implicit* masks. For example, if you omit the mask from an associated IP host address access list specification, 0.0.0.0 is assumed to be the mask. Consider the following example configuration:

```
Switch(config)# access-list 1 permit 0.0.0.0
Switch(config)# access-list 1 permit 131.108.0.0
Switch(config)# access-list 1 deny 0.0.0.0 255.255.255.255
```

For this example, the following masks are implied in the first two lines:

```
Switch(config)# access-list 1 permit 0.0.0.0 0.0.0.0
Switch(config)# access-list 1 permit 131.108.0.0 0.0.0.0
```

The last line in the configuration (using the **deny** keyword) can be omitted, because IP access lists implicitly *deny* all other access, which is equivalent to finishing the access list with the following command statement:

```
Switch(config)# access-list 1 deny 0.0.0.0 255.255.255.255
```

The following access list only allows access for those hosts on the three specified networks. It assumes that subnetting is not used; the masks apply to the host portions of the network addresses. Any hosts with a source address that does not match the access list statements is rejected.

```
Switch(config)# access-list 1 permit 192.5.34.0 0.0.0.255
Switch(config)# access-list 1 permit 128.88.0.0 0.0.255.255
Switch(config)# access-list 1 permit 36.0.0.0 0.255.255.255
! (Note: all other access implicitly denied)
```

To specify a large number of individual addresses more easily, you can omit the address mask that is all zeros from the **access-list** global configuration command. Thus, the following two configuration commands are identical in effect:

```
Switch(config)# access-list 2 permit 36.48.0.3
Switch(config)# access-list 2 permit 36.48.0.3 0.0.0.0
```

Examples of Configuring Extended IP Access Lists

In the following example, the first line permits any incoming Transmission Control Protocol (TCP) connections with destination ports greater than 1023. The second line permits incoming TCP connections to the simple mail transfer protocol (SMTP) port of host 128.88.1.2. The last line permits incoming ICMP messages for error feedback.

```
Switch(config)# access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.0.0 0.0.255.255 gt 1023
Switch(config)# access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.1.2 0.0.0.0 eq 25
Switch(config)# access-list 102 permit icmp 0.0.0.0 255.255.255.255 128.88.0.0 255.255.255.255
Switch(config)# interface ethernet0
Switch(config-if)# ip access-group 102 in
```

As another example, suppose you have a network connected to the Internet, and you want any host on an Ethernet to be able to form TCP connections to any host on the Internet. However, you do not want IP hosts to be able to form TCP connections to hosts on the Ethernet except to the mail (SMTP) port of a dedicated mail host.

SMTP uses TCP port 25 on one end of the connection and a random port number on the other end. The same two port numbers are used throughout the life of the connection. Mail packets coming in from the Internet have a destination port of 25. Outbound packets will have the port numbers reversed. The fact that the secure system behind the switch always accepts mail connections on port 25 is what makes it possible to separately control incoming and outgoing services. The access list can be configured on either the outbound or inbound interface.

In the following example, the Ethernet network is a Class B network with the address 128.88.0.0, and the mail host's address is 128.88.1.2. The keyword **established** is used only for the TCP protocol to indicate an established connection. A match occurs if the TCP datagram has the acknowledgment (ACK) or RST bits set, indicating that the packet belongs to an existing connection.

```
Switch(config)# access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.0.0 0.0.255.255 established
Switch(config)# access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.1.2 0.0.0.0 eq 25
Switch(config)# interface ethernet0
Switch(config-if)# ip access-group 102 in
```

Configuring Per-Interface Address Registration with Optional Access Filters

The ATM switch router allows configuration of per-interface access filters for Integrated Local Management Interface (ILMI) address registration to override the global default of access filters.

To configure ILMI address registration and the optional access filters for a specified interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm address-registration permit** {**all** | **matching-prefix** [**all-groups** | **wellknown-groups**]}	Configures ILMI address registration and the optional access filters for a specified interface.

Example

The following example shows how to configure ILMI address registration on an individual interface to permit all groups with a matching ATM address prefix:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm address-registration permit matching-prefix all-groups
%ATM-5-ILMIACCFILTER: New access filter setting will be applied to registration
of new addresses on ATM3/0/0.
Switch(config-if)#
```

Displaying the ILMI Access Filter Configuration

To display the interface ILMI address registration access filter configuration, use the following EXEC command:

Command	Purpose
more system:running-config	Displays the interface ILMI address registration access filter configuration.

Example

The following example displays address registration access filter configuration for ATM interface 3/0/0:

```
Switch# more system:running-config
Building configuration...
Current configuration:
!
version XX.X
no service pad

<Information Deleted>

interface ATM0
 no ip address
 atm maxvp-number 0
!
interface Ethernet0
 ip address 172.20.41.110 255.255.255.0
 ip access-group 102 out
!
interface ATM3/0/0
 no atm auto-configuration
 atm address-registration permit matching-prefix all-groups
 atm iisp side user
 atm pvc 100 200
 atm signalling cug access permit-unknown-cugs both-direction permanent
 atm accounting
!
interface ATM3/0/1
!

<information deleted>
```

Configuring IP over ATM

This chapter describes how to configure IP over ATM on the ATM switch router. The primary use of IP over ATM is for inband management of the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For further information about Layer 3 protocols over ATM, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Configuring Classical IP over ATM

This section describes configuring a port on a ATM switch router to allow a classical IP-over-ATM connection to the ATM switch router's route processor and optional ATM router module.

The following sections describe configuring the ATM switch router for classical IP over ATM in either a switched virtual channel (SVC) or permanent virtual channel (PVC) environment.

Configuring Classical IP over ATM in an SVC Environment

This section describes classical IP over ATM in an SVC environment. It requires configuring only the device's own ATM address and that of a single ATM Address Resolution Protocol (ARP) server into each client device.

For a detailed description of the role and operation of the ATM ARP server, refer to the *Guide to ATM Technology*.

The ATM switch router can be configured as an ATM ARP client to work with any ATM ARP server conforming to RFC 1577. Alternatively, one of the ATM switch routers in a logical IP subnet (LIS) can be configured to act as the ATM ARP server itself. In that case, it automatically acts as a client as well. The following sections describe configuring the ATM switch router in an SVC environment as either an ATM ARP client or an ATM ARP server.

Configuring as an ATM ARP Client

In an SVC environment, configure the ATM ARP mechanism on the interface by performing the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0** Switch(config-if)# or Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the route processor interface. or If you are using the optional Catalyst 8540 MSR enhanced ATM router module, specifies the ATM interface number.
Step 2	Switch(config-if)# **atm nsap-address** *nsap-address* or Switch(config-if)# **atm esi-address** *esi***.***selector*	Specifies the network service access point (NSAP) ATM address of the interface. or Specifies the end-system-identifier (ESI) address of the interface.
Step 3	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 4	Switch(config-if)# **atm arp-server nsap** *nsap-address*	Specifies the ATM address of the ATM ARP server.
Step 5	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 6	Switch(config)# **atm route** *addr-prefix*[1] {**atm 0** | **atm** *card***/***subcard***/***port*} **internal**	Configures a static route through the ATM switch router to the route processor interface, or the optional Catalyst 8540 MSR enhanced ATM router module interface. See the following note.

1. Address prefix is first 19 bytes of the NSAP address.

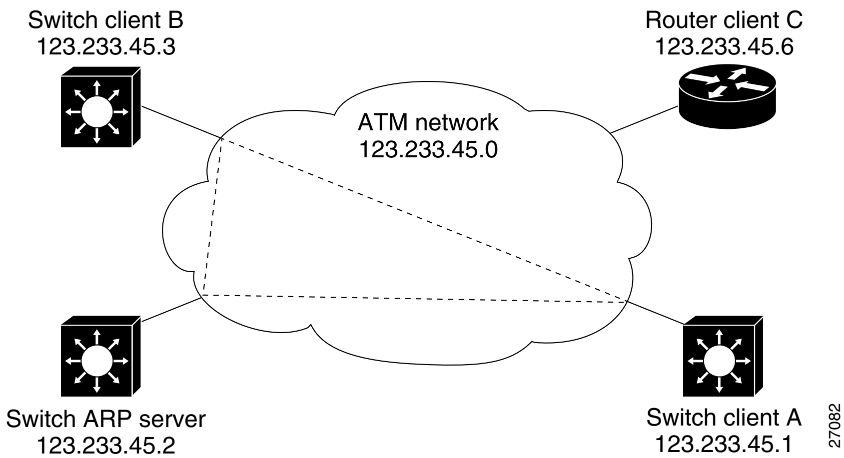
Note The end system identifier (ESI) address form is preferred in that it automatically handles the advertising of the address. Use the network service access point (NSAP) form of the command when you need to define a full 20-byte unique address with a prefix unrelated to the network prefix on that interface. You only need to specify a static route when configuring an ARP client using an NSAP address.

Note Since the 12.0(1a)W5(5b) release of the system software, addressing the interface on the route processor has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. The old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

NSAP Address Example

Figure 13-1 shows three ATM switch routers and a router connected using classical IP over ATM.

Figure 13-1 Classical IP over ATM Connection Setup



The following example shows how to configure the route processor interface ATM 0 of client A in Figure 13-1, using the NSAP address:

```
Client A(config)# interface atm 0
Client A(config-if)# atm nsap-address 47.0091.8100.0000.1111.1111.1111.1111.1111.1111.00
Client A(config-if)# ip address 123.233.45.1 255.255.255.0
Client A(config-if)# atm arp-server nsap 47.0091.8100.0000.1111.1111.1111.2222.2222.2222.00
Client A(config-if)# exit
Client A(config)# atm route 47.0091.8100.0000.1111.1111.1111.1111.1111.1111 atm 0 internal
```

ESI Example

The following example shows how to configure route processor interface ATM 0 of client A in Figure 13-1 using the ESI:

```
Client A(config)# interface atm 0
Client A(config-if)# atm esi-address 0041.0b0a.1081.40
Client A(config-if)# ip address 123.233.45.1 255.255.255.0
Client A(config-if)# atm arp-server nsap 47.0091.8100.0000.1111.1111.1111.2222.2222.2222.00
Client A(config-if)# exit
Client A(config)# atm route 47.0091.8100.0000.1111.1111.1111.1111.1111.1111 atm 0 internal
```

Configuring as an ATM ARP Server

Cisco's implementation of the ATM ARP server supports a single, nonredundant server per LIS and one ATM ARP server per subinterface. Thus, a single ATM switch router can support multiple ARP servers by using multiple interfaces.

To configure the ATM ARP server, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0**[**.***subinterface#*] Switch(config-if)#	Selects the route processor interface.
	or	or
	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***subinterface#*] Switch(config-if)#	If you are using the optional Catalyst 8540 MSR enhanced ATM router module, specifies the ATM interface number.
Step 2	Switch(config-if)# **atm nsap-address** *nsap-address*	Specifies the NSAP ATM address of the interface.
	or	or
	Switch(config-if)# **atm esi-address** *esi***.***selector*	Specifies the end-system-identifier address of the interface.
Step 3	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 4	Switch(config-if)# **atm arp-server self** [**time-out** *minutes*][1]	Configures this interface as the ATM ARP server for the logical IP network.
Step 5	Switch(config-if)# **atm route** *addr-prefix*[2] {**atm 0** | **atm** *card***/***subcard***/***port*} **internal**	Configures a static route through the ATM switch router to the route processor interface, or the optional Catalyst 8540 MSR enhanced ATM router module interface. See the following note.

1. This form of the **atm arp-server** command indicates that this interface performs the ATM ARP server functions. When you configure the ATM ARP client (described earlier), the **atm arp-server** command is used—with a different keyword and argument—to identify a different ATM ARP server to the client.
2. Address prefix is first 19 bytes of the NSAP address.

Note The ESI address form is preferred in that it automatically handles the advertising of the address. Use the NSAP form of the command when you need to define a full 20-byte unique address with a prefix unrelated to the network prefix on that interface. You only need to specify a static route when configuring an ARP server using an NSAP address.

The idle timer interval is the number of minutes a destination entry listed in the ATM ARP server ARP table can be idle before the server takes any action to timeout the entry.

Example

The following example configures the route processor interface ATM 0 as an ARP server (shown in Figure 13-1):

```
ARP_Server(config)# interface atm 0
ARP_Server(config-if)# atm esi-address 0041.0b0a.1081.00
ARP_Server(config-if)# atm arp-server self
ARP_Server(config-if)# ip address 123.233.45.2 255.255.255.0
Client A(config)# atm route 47.0091.8100.0000.1111.1111.1111.1111.1111.1111 atm 0 internal
```

Displaying the IP-over-ATM Interface Configuration

To show the IP-over-ATM interface configuration, use the following EXEC commands:

Command	Purpose
show atm arp-server	Shows the ATM interface ARP configuration.
show atm map	Shows the ATM map list configuration.

Examples

In the following example, the **show atm arp-server** command displays the configuration of the interface ATM 0:

```
Switch# show atm arp-server

Note that a '*' next to an IP address indicates an active call

      IP Address        TTL     ATM Address
ATM2/0/0:
    * 10.0.0.5          19:21   4700918100567000000000112200410b0a108140
```

The following example displays the map-list configuration of the static map and IP-over-ATM interfaces:

```
Switch# show atm map
Map list ATM2/0/0_ATM_ARP : DYNAMIC
arp maps to NSAP 36.0091810000000003D5607900.0003D5607900.00
        , connection up, VPI=0 VCI=73, ATM2/0/0
ip 5.1.1.98 maps to s 36.0091810000000003D5607900.0003D5607900.00
        , broadcast, connection up, VPI=0 VCI=77, ATM2/0/0

Map list ip : PERMANENT
ip 5.1.1.99 maps to VPI=0 VCI=200
```

Configuring Classical IP over ATM in a PVC Environment

This section describes how you configure classical IP over ATM in a permanent virtual channel (PVC) environment. The ATM Inverse ARP (InARP) mechanism is applicable to networks that use PVCs, where connections are established but the network addresses of the remote ends are not known. A server function is *not* used in this mode of operation.

In a PVC environment, configure the ATM InARP mechanism by performing the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0** Switch(config-if)# or Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the route processor interface. If you are using the optional ATM router module, specifies the ATM interface number.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 3	Switch(config-if)# **atm pvc** [**0** | **2**] *vci* **interface atm** *card*/*subcard*/*port vpi vci* **encap** [**aal5mux** | **aal5snap**] [**inarp** *minutes*]	Creates a PVC and enables Inverse ARP. The VPI value on interface ATM 0 is 0. The VPI value on an ATM router module interface is 2.

Repeat these tasks for each PVC you want to create.

The **inarp** *minutes* interval specifies how often Inverse ARP datagrams are sent on this virtual circuit. The default value is 15 minutes.

Note The ATM ARP and ATM InARP mechanisms work with IP only. All other protocols require **map-list** command entries to operate.

Example

The following example shows how to configure an IP-over-ATM interface on interface ATM 0, using a PVC with AAL5SNAP encapsulation, inverse ARP set to ten minutes, VPI = 0, and VCI = 100:

```
Switch(config)# interface atm 0
Switch(config-if)# ip address 11.11.11.11 255.255.255.0
Switch(config-if)# atm pvc 0 100 interface atm 0/0/0 50 100 encap aal5snap inarp 10
```

Displaying the IP-over-ATM Interface Configuration

To show the IP-over-ATM interface configuration, use the following EXEC command:

Command	Purpose
show atm map	Shows the ATM interface ARP configuration.

Example

The following example displays the map-list configuration of the static map and IP-over-ATM interfaces:

```
Switch# show atm map
Map list yyy : PERMANENT
ip 1.1.1.2 maps to VPI=0 VCI=200

Map list zzz : PERMANENT

Map list a : PERMANENT

Map list 1 : PERMANENT

Map list ATM2/0/0_ATM_ARP : DYNAMIC
arp maps to NSAP 47.00918100567000000001122.00410B0A1081.40
        , connection up, VPI=0 VCI=85, ATM2/0/0
ip 10.0.0.5 maps to NSAP 47.00918100567000000001122.00410B0A1081.40
        , broadcast, ATM2/0/0
```

Mapping a Protocol Address to a PVC Using Static Map Lists

The ATM interface supports a static mapping scheme that identifies the ATM address of remote hosts or ATM switch routers. This IP address is specified as a permanent virtual channel (PVC) or as a network service access point (NSAP) address for switch virtual channel (SVC) operation.

The following sections describe configuring both PVC-based and SVC-based map lists on the ATM switch router. For a more detailed discussion of static map lists, refer to the *Guide to ATM Technology*.

Configurations for both PVC and SVC map lists are described in the following sections:

- Configuring a PVC-Based Map List, page 13-7
- Configuring an SVC-Based Map List, page 13-9

Configuring a PVC-Based Map List

This section describes how to map a PVC to an address, which is a required task if you are configuring a PVC.

You enter mapping commands as groups. You first create a map list and then associate it with an interface. Perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config-if)# **interface atm** *card***/***subcard***/***port*[**.***subinterface*#]	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Enters the IP address and subnet mask associated with this interface.
Step 3	Switch(config-if)# **map-group** *name*	Enters the map group name associated with this PVC.

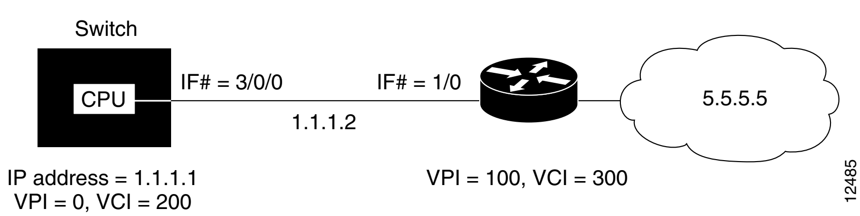
	Command	Purpose
Step 4	Switch(config-if)# **atm pvc** *vpi-a vci-a* [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] **interface atm** *card***/***subcard***/***port*[**.***vpt#*] *vpi-b vci-b* [**upc** *upc*] [**encap** *aal-encap*]	Configures the PVC.
Step 5	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 6	Switch(config)# **ip route** *ip-address mask forward-ip address*	Configures an IP route to the router.
Step 7	Switch(config)# **map-list** *name* Switch(config-map-list)#	Creates a map list by naming it, and enters map-list configuration mode.
Step 8	Switch(config-map-list)# **ip** *ip-address* {**atm-nsap** *address* | **atm-vc** *vci*} [**aal5mux** *encapsulation*] [**broadcast** *pseudo-broadcast*] [**class** *class-name*]	Associates a protocol and address to a specific virtual circuit.

You can create multiple map lists, but only one map list can be associated with an interface. Different map lists can be associated with different interfaces.

Example

Figure 13-2 illustrates a connection configured with a PVC map list.

Figure 13-2 PVC Map List Configuration Example



The following example shows the commands used to configure the connection in Figure 13-2.

```
Switch(config)# interface atm 0
Switch(config-if)# ip address 1.1.1.1 255.0.0.0
Switch(config-if)# map-group yyy
Switch(config-if)# atm pvc 0 200 interface atm 3/0/0 100 300 encap aal5snap
Switch(config-if)# exit
Switch(config)# ip route 1.1.1.1 255.0.0.0 1.1.1.2
Switch(config)# map-list yyy
Switch(config-map-list)# ip 1.1.1.2 atm-vc 200
```

Displaying the Map-List Interface Configuration

To show the map-list interface configuration, use the following EXEC command:

Command	Purpose
show atm map	Shows the ATM interface map-list configuration.

Example

The following example displays the map-list configuration at interface ATM 0:

```
Switch# show atm map
Map list yyy : PERMANENT
ip 1.1.1.2 maps to VPI=0 VCI=200
```

Configuring an SVC-Based Map List

This section describes how to map an SVC to an NSAP address. This is a required task if you are configuring an SVC.

You enter mapping commands as groups. You first create a map list and then associate it with an interface. Perform the following steps, beginning in global configuration mode:

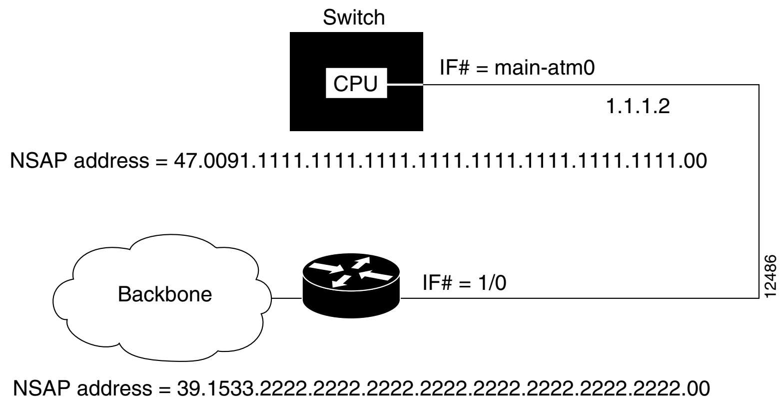
	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***subinterface#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Enters the IP address and subnet mask associated with this interface.
Step 3	Switch(config-if)# **atm nsap-address** *nsap-address*	Configures the interface NSAP address.
Step 4	Switch(config-if)# **map-group** *name*	Enters the map-group name associated with this PVC.
Step 5	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 6	Switch(config)# **map-list** name Switch(config-map-list)#	Creates a map list by naming it, and enters map-list configuration mode.
Step 7	Switch(config-map-list)# **ip** *ip-address* {**atm-nsap** *address* | **atm-vc** *vci*} [**aal5mux** *encapsulation*] [**broadcast** *pseudo-broadcast*] [**class** *class-name*]	Associates a protocol and address to a specific virtual circuit.

You can create multiple map lists, but only one map list can be associated with an interface. Different map lists can be associated with different interfaces.

Examples

Figure 13-3 illustrates an SVC connection configured with a map list.

Figure 13-3 SVC Map-List Configuration Example



The following example shows the commands used to configure the connection in Figure 13-3:

```
Switch(config)# interface atm 0
Switch(config-if)# ip address 1.1.1.1 255.0.0.0
Switch(config-if)# atm nsap-address 47.0091.1111.1111.1111.1111.1111.1111.1111.1111.00
Switch(config-if)# map-group zzz
Switch(config-if)# exit
Switch(config)# map-list zzz
Switch(config-map-list)# ip 1.1.1.2 atm-nsap 39.1533.2222.2222.2222.2222.2222.2222.2222.2222.00
```

Displaying the Map-List Interface Configuration

To show the map-list interface configuration, use the following EXEC command:

Command	Purpose
show atm map	Shows the ATM interface map-list configuration.

Example

The following example displays the map-list configuration at interface ATM 0:

```
Switch# show atm map

Map list zzz : PERMANENT
ip 1.1.1.2 maps to NSAP AC.153322222222222222222222.222222222222.00
```

Policy-Based Routing

Policy-based routing (PBR) allows you to do the following:

- Classify traffic based on extended access list criteria.
- Set IP Precedence bits.
- Route specific traffic to engineered paths, which may be required to allow a specific QoS service through the network.

Classification of traffic through PBR is based on standard or named Access Control Lists (ACLs) and IP packet length. Some possible applications for policy routing are to provide equal access, protocol-sensitive routing, source-sensitive routing, routing based on interactive versus batch traffic, or routing based on dedicated links.

For more information on policy-based routing, including configuration examples, refer to the Cisco IOS Quality of Service Solutions Configuration Guide, Release 12.1.

Policy-Based Routing Restrictions

The following restrictions apply to policy-based routing (PBR) on the Catalyst 8540 MSR and the Catalyst 8540 CSR:

- PBR is supported only on the Enhanced Gigabit interface.
- The IP interface for egress must be supported by the Catalyst 8540 MSR and the Catalyst 8540 CSR.
- Fast-switched PBR cannot be enabled because the Catalyst 8540 is a line rate switch.
- When configuring IP QoS to rewrite precedence and PBR to rely on precedence set by an ACL, the classification for PBR uses the original packet precedence, not the rewritten IP QoS value.
- Changes in the TCAM space for a PBR region must be specified with the **sdm policy size** command. The changes take effect upon reboot. The default PBR TCAM size is 0.
- The following commands are supported:
  - **match ip address** {***access-list***-*number* | *name*} [***...access-list***-*number* | *name*]
  - **match length** ***min max***

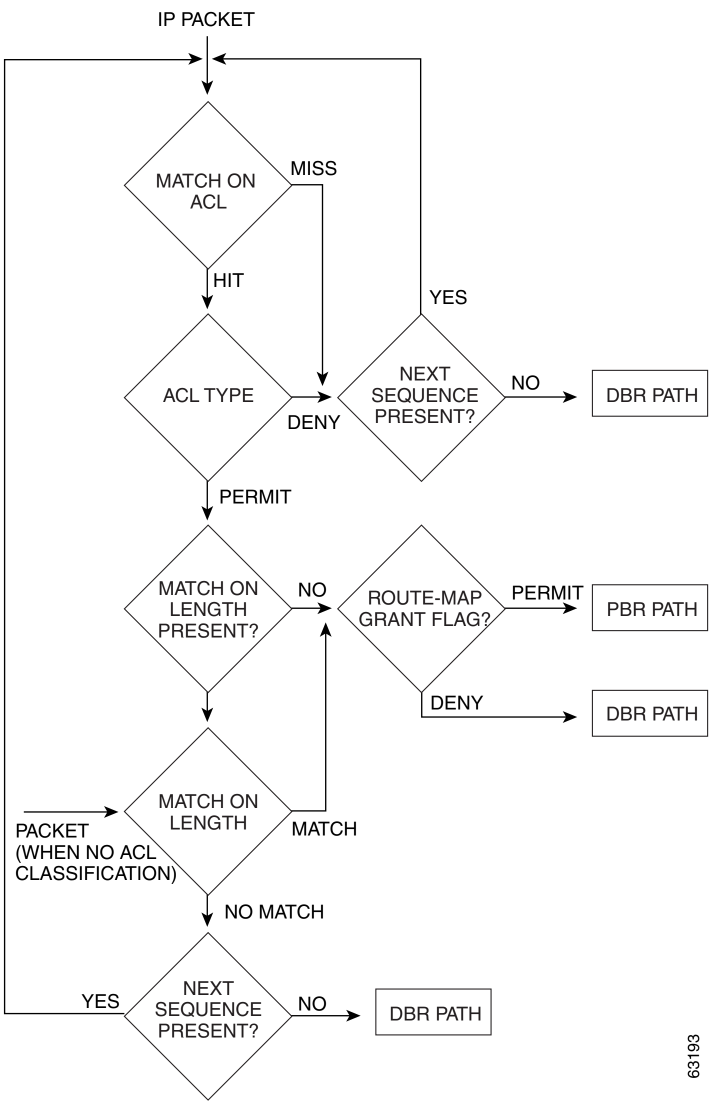
> **Note** The IP packet length range supported in a route map is 0-1535. A maximum of three non-overlapping length ranges are allowed per interface, including sub-interfaces.

- The following **set** command options are supported for PBR:
  - **ip precedence**
  - **ip next-hop**
  - **interface**
  - **interface null0**.

> **Note** Due to platform limitations, the **set interface null0** command does not generate an “unreachable” message.

- The following commands are not supported:
  - **set ip default next-hop**
  - **set ip default interface**
- When you configure a policy to rewrite precedence with a next hop interface, the precedence is rewritten only when the packet flows via the supported PBR path. If the next-hop is not accessible, the original precedence is retained since the packet flows via DBR (destination based routing). Figure 13-4 illustrates the supported PBR path for IP packet flow on the Catalyst 8540 MSR and the Catalyst 8540 CSR.

Figure 13-4 IP Packet Flow for PBR



Configuring IP Load Sharing

Load sharing allows a device to distribute the outgoing and incoming traffic among multiple best paths to a particular destination. In per packet load sharing, each packet is distributed among multiple best paths to the destination. On the Catalyst 8540 MSR, Catalyst 8510 MSR and LightStream 1010 platforms, per packet load sharing can be enabled for all packets or for TCP packets only.

Configuring TCP Packet Load Sharing

To enable per-packet load sharing for TCP traffic only on an interface, use the following interface configuration command:

Command	Purpose
ip load-sharing per-packet	Enables per-packet load sharing for TCP traffic only.

Note This command is only available for Gigabit Ethernet line cards.

Note This feature should only be used with switches equipped with Enhanced ATM Router Modules. This command cannot be used with switches equipped with standard ATM Router Modules.

Note Per packet load balancing should not be configured on MPLS-enabled interfaces.

Example

The following example enables load-sharing for TCP packets on ethernet interface 0:

```
Switch# configure terminal
Switch(config)# interface ethernet 0
Switch(config-if)# ip load-sharing per-packet
```

Configuring Packet Load Sharing for all IP Traffic

To enable per-packet load sharing for all IP traffic, perform the following steps in interface configuration mode:

	Command	Purpose
Step 1	Switch(config-if)# **ip load-sharing per-packet**	Enables per packet load sharing on an interface on the router

	Command	Purpose
Step 2	Switch(config-if)# **exit**	Exits interface configuration mode.
Step 3	Switch(config)# **epc xpif-ip-per-pack-all**	Enables per packet load sharing for all IP traffic for interface enabled with the **ip load-sharing per-packet enable command**.

Note This feature is only available for Gigabit Ethernet line cards.

Note This feature should only be used with switches equipped with Enhanced ATM Router Modules. This command cannot be used with switches equipped with standard ATM Router Modules.

Note Per packet load balancing should not be configured on MPLS-enabled interfaces.

Example

The following example enables load-sharing for all IP packets on ethernet interface 0:

```
Switch# configure terminal
Switch(config)# interface ethernet 0
Switch(config-if)# ip load-sharing per-packet
Switch(config-if)# exit
Switch(config)# epc xpif-ip-per-pack-all
```

CHAPTER 14

Configuring LAN Emulation

This chapter describes LAN emulation (LANE) and how to configure it on the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For an overview of LANE architecture and operation, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For a detailed description of LANE and its components, refer to *Cisco IOS Switching Services Configuration Guide: Virtual LANs*.

This chapter contains the following sections:

LANE Functionality and Requirements

LANE uses ATM as a backbone to interconnect existing legacy LANs. In doing so, LANE allows legacy LAN users to take advantage of ATM's benefits without requiring modifications to end station hardware or software.

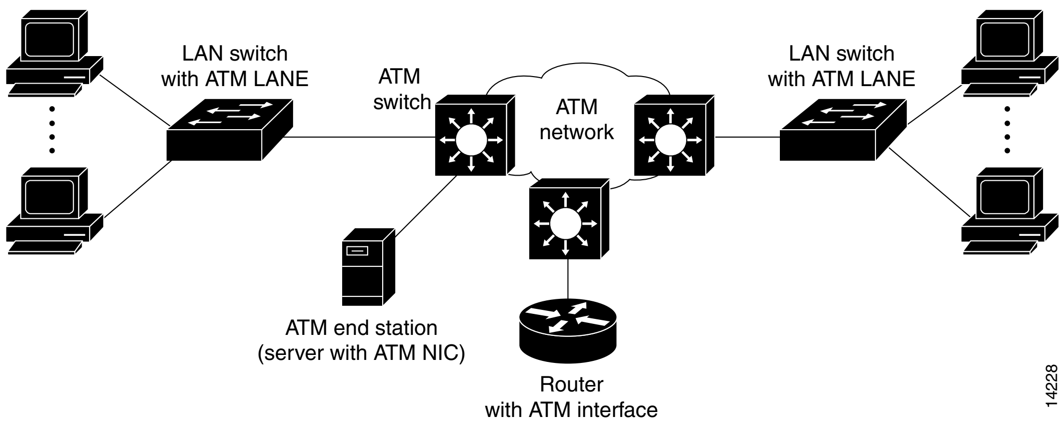
Multiple emulated LANs (ELANs), which are logically separated, can share the same physical ATM network and the same physical ATM interface. LANE makes an ATM interface look like one or more separate Ethernet or Token Ring interfaces.

LANE services provide connectivity between ATM-attached devices and LAN-attached devices. Two primary applications for the LANE protocol are as follows:

- Connectivity between LAN-attached stations across an ATM network, effectively extending LANs over a high-speed ATM transport backbone.
- Connectivity between ATM-attached hosts and LAN-attached hosts. Centralized hosts with high-speed ATM port adapters provide services, such as Domain Name System (DNS), to traditional LAN-attached devices.

Figure 14-1 illustrates the various connections LANE provides.

Figure 14-1 LANE Concept



Refer to the *Guide to ATM Technology* for the following background topics on LANE:

- How LANE works—the operation of LANE and the function of ATM network devices in LANE
- LANE components—the function of the server and client components that are required for LANE
- LANE virtual circuit connection (VCC) types—the role of each VCC type in establishing, maintaining, and tearing down LANE connections
- Addressing—the scheme used in automatically assigning ATM addresses to LANE components
- LANE examples—step-by-step process of joining an emulated LAN and building a LANE connection from a PC

LANE Router and Switch Router Requirements

You must manually configure Q.2931 over Signaling ATM Adaptation Layer (QSAAL) and ILMI signalling PVCs on routers and edge LAN switch routers to run LANE. However, these signalling permanent virtual channels (PVCs) are automatically configured on the ATM switch router.

Note The Catalyst 8510 MSR and LightStream 1010 processor and port adapters can be installed in slots 9 through 13 of the Catalyst 5500 switch. In this case, no physical connection is required between the ATM port adapter and the LANE card if the ATM Fabric Integration Module is used.

At least one ATM switch router is required to run LANE. For example, you cannot run LANE on routers connected back-to-back.

LANE Configuration Tasks

Before you begin to configure LANE, you must decide whether you want to set up one or multiple emulated LANs. If you set up multiple emulated LANs, you must also decide where the servers and clients will be located, and whether to restrict the clients that can belong to each emulated LAN. The procedure for configuring bridged emulated LANs is the same as for any other LAN.

To configure LANE, complete the tasks in the following sections:

- Creating a LANE Plan and Worksheet, page 14-3
- Displaying LANE Default Addresses, page 14-6
- Entering the ATM Address of the Configuration Server, page 14-7
- Setting Up the Configuration Server Database, page 14-7

Note For fault tolerance, multiple LANE services and servers can be assigned to the emulated LAN. This requires the use of our ATM switch routers and our ATM edge devices end-to-end.

- Enabling the Configuration Server, page 14-10

  An ATM cloud can contain multiple configuration servers.

- Setting Up LESs and Clients, page 14-11

  Every ELAN must have at least a LAN emulation server/broadcast-and unknown server (LES/BUS) pair, the maximum is 10. Every LANE cloud (one or multiple ELANs) must have at least one LAN emulation configuration server (LECS).

You can configure some emulated LANs with unrestricted membership and some emulated LANs with restricted membership. You can also configure a default emulated LAN, which must have unrestricted membership.

After LANE is configured, you can monitor and maintain the components, as described in the Monitoring and Maintaining the LANE Components, page 14-16.

Creating a LANE Plan and Worksheet

Draw up a plan and a worksheet for your LANE scenario, containing the following information and leaving spaces for the ATM address of each LANE component on each subinterface of each participating router or switch router:

- The component and interface where the LECS will be located.
- The component, interface, and subinterface where the LES and BUS for each emulated LAN will be located. Each emulated LAN has multiple servers for fault-tolerant operation.
- The component, interfaces, and subinterfaces where the clients for each emulated LAN will be located.
- The component and database name of the default database.
- The name of the default emulated LAN (optional).
- The names of the emulated LANs that have unrestricted membership.
- The names of the emulated LANs that have restricted membership.

The last three items in this list are very important; they determine how you set up each emulated LAN in the configuration server database.

Automatic ATM Addressing and Address Templates for LANE Components

The ATM switch router automatically assigns ATM addresses to LANE components using the scheme described in the *Guide to ATM Technology*. You can also override the automatic address assignments using an ATM address template.

You can use ATM address templates in many LANE commands that assign ATM addresses to LANE components or that link client ATM addresses to emulated LANs. Using templates can greatly simplify the use of these commands.

Note E.164-format ATM addresses do not support the use of LANE ATM address templates.

LANE ATM address templates can use two types of wildcards: an asterisk (*) to match any single character, and an ellipsis (...) to match any number of leading or trailing characters.

In LANE, a *prefix template* explicitly matches the prefix but uses wildcards for the end station interface (ESI) and selector fields. An *ESI template* explicitly matches the ESI field but uses wildcards for the prefix and selector fields. Table 14-1 shows how the values of unspecified digits are determined when an ATM address template is used.

Table 14-1 Values of Unspecified Digits in ATM Address Templates

Unspecified Digits In	Value Is
Prefix (first 13 bytes)	Obtained from ATM switch router via Integrated Local Management Interface (ILMI)
ESI (next 6 bytes)	Filled with the slot MAC address[1] plus • 0—LANE Client (LEC) • 1—LANE Server (LES) • 2—LANE broadcast-and-unknown server (BUS) • 3—LANE Configuration Server (LECS)
Selector field (last 1 byte)	Subinterface number, in the range 0 through 255

1. The lowest MAC addresses in the pool addresses assigned to the ATM interface plus a value that indicates the LANE component.

Rules for Assigning Components to Interfaces and Subinterfaces

The following rules apply to assigning LANE components to the major ATM interface and its subinterfaces:

- The LECS always runs on the major interface.

  The assignment of any other component to the major interface is identical to assigning that component to the 0 subinterface.
- The server and the client of the *same* emulated LAN can be configured on the same subinterface.
- Clients of two *different* emulated LANs cannot be configured on the same subinterface.
- Servers of two *different* emulated LANs cannot be configured on the same subinterface.

Note On the ATM switch router, LANE components can be configured only on the multiservice route processor interface or on one of its subinterfaces.

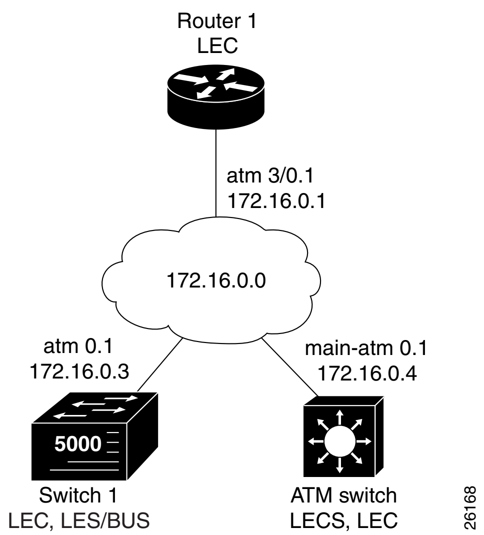
Example LANE Plan and Worksheet

This section is an example of the LANE plan and worksheet that would be created for the example network configuration described in Default Configuration for a Single Emulated LAN, page 14-17.

Note This example configures LANE on the route processor interface (ATM 0), rather than an ATM router module interface. For LANE client configuration examples on ATM router module interfaces, see Chapter 25, "Configuring ATM Router Module Interfaces."

Figure 14-2 shows the single emulated LAN example network.

Figure 14-2 LANE Plan Example Network



The following information describes the LANE plan in Figure 14-2:

- LECS:
  —Location: ATM_Switch
  —Interface: atm 0
  —ATM address: 47.00918100000000E04FACB401.00E04FACB405.00
- LES:
  —Location: Switch_1
  —Interface/Subinterface: atm 0.1
  —Type: Ethernet
  —ATM address: 47.00918100000000E04FACB401.00E04FACB403.01
- BUS:
  —Location: Switch_1
  —Interface/Subinterface: atm 0.1
  —Type: Ethernet
  —ATM address: "use default"
- Database:
  —Location: ATM_Switch
  —Name: eng_dbase

—ELAN name: eng_elan
—Default ELAN name: eng_elan
—ATM address: 47.00918100000000E04FACB401.00E04FACB403.01

- LANE Client:
  —Location: ATM_Switch
  —Interface/Subinterface: atm 0.1
  —Server/BUS name: eng_elan
  —IP Address/Subnet mask: 172.16.0.4 255.255.0.0
  —Type: Ethernet
- LANE Client:
  —Location: Switch_1
  —Interface/Subinterface: atm 0.1
  —Server/BUS name: eng_elan
  —Type: Ethernet
- LANE Client:
  —Location: Router_1
  —Interface/Subinterface: atm 3/0.1
  —Server/BUS name: eng_elan
  —IP Address/Subnet mask: 172.16.0.1 255.255.0.0
  —Type: Ethernet

Note Virtual LANs (VLANs) need to be configured on the LAN edge switches. These VLANs must be mapped to the appropriate ELANs.

Continue with the following sections to start configuring LANE on your ATM network.

Displaying LANE Default Addresses

To make configuration easier, you should display the LANE default addresses for each router or switch router that is running any of the LESs or services and write down the displayed addresses on your worksheet.

To display the default LANE addresses, use the following EXEC command:

Command	Purpose
show lane default-atm-addresses	Displays the LANE default addresses for all ATM interfaces present on the router or switch router.

Example

The following example displays the default LANE addresses:

```
Switch# show lane default-atm-addresses
interface ATM13/0/0:
LANE Client:        47.00918100000000E04FACB401.00E04FACB402.**
LANE Server:        47.00918100000000E04FACB401.00E04FACB403.**
LANE Bus:           47.00918100000000E04FACB401.00E04FACB404.**
LANE Config Server: 47.00918100000000E04FACB401.00E04FACB405.00
note: ** is the subinterface number byte in hex
```

Entering the ATM Address of the Configuration Server

You must enter the configuration server ATM address into the ATM switch routers and save it permanently, so that the value is not lost when the device is reset or powered off. The configuration server address can be specified for all of the ATM switch routers, or per port.

To enter the configuration server addresses for all of the ATM switch routers, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm lecs-address-default** *lecsaddress*	Specifies the LECS ATM address for all of the ATM switch routers.
Step 2	Switch(config)# **end** Switch#	Exits configuration mode.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Saves the configuration.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Setting Up the Configuration Server Database

After you have determined all LESs, BUSs, and LECS on all ATM subinterfaces on all routers and switch routers that will participate in LANE, and have displayed their ATM addresses, you can use the information to populate the configuration server's database.

You can set up a default emulated LAN, whether or not you set up any other emulated LANs. You can also set up some emulated LANs with restricted membership and others with unrestricted membership.

To set up the LANE database, complete the tasks in the following subsections as appropriate for your emulated LAN plan and scenario. To set up fault-tolerant operation, see Configuring Fault-Tolerant Operation, page 14-15.

Setting Up the Database for the Default Emulated LAN Only

When you configure a router as the LECS for one default emulated LAN, you provide the following information:

- A name for the database
- The ATM address of the server for the emulated LAN
- The ring number of the emulated LAN for Token Ring (Catalyst 8510 MSR and LightStream 1010)
- A default name for the emulated LAN

When you set up a database of only a default unrestricted emulated LAN, you do not have to specify where the LANE *clients* are located. That is, when you set up the configuration servers database for a single default emulated LAN, you do not have to provide any database entries that link the ATM addresses of any clients with the emulated LAN name.

To set up the LECS for the default emulated LAN, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **lane database** *database-name* Switch(lane-config-database)#	Creates a named database for the LECS.
Step 2	Switch(lane-config-database)# **name** *elan-name* **server-atm-address** *atm-address* [**index** *n*]	In the configuration database, binds the name of the emulated LAN to the ATM address of the LES.
Step 3	Switch(lane-config-database)# **name** *elan-name* **local-seg-id** *seg-num*	(Token Ring only.) In the configuration database, specifies the ring number for the emulated LAN. (Catalyst 8510 MSR and LightStream 1010)
Step 4	Switch(lane-config-database)# **default-name** *elan-name*	In the configuration database, assigns an emulated LAN to the LECS trying to join without specifying an ELAN name.

In Step 2, enter the ATM address of the server for the specified emulated LAN, as noted in your worksheet and obtained in Displaying LANE Default Addresses, page 14-6. You can have any number of servers per emulated LAN for fault tolerance. Entry order determines priority: the first entry has the highest priority unless you override it with the index option.

If you are setting up only a default emulated LAN, the *elan-name* value in Step 2 is the same as the default emulated LAN name you provide in Step 4.

To set up fault-tolerant operation, see Configuring Fault-Tolerant Operation, page 14-15.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Setting Up the Database for Unrestricted-Membership Emulated LANs

When you set up a database for unrestricted emulated LANs, you create database entries that link the name of each emulated LAN to the ATM address of its *server.*

However, you can choose *not* to specify the locations of the LANE clients. That is, when you set up the configuration server database, you do not have to provide any database entries that link the ATM addresses or media access control (MAC) addresses of any *clients* with the emulated LAN name.

To configure a router or switch router as the LECS for multiple emulated LANs with unrestricted membership, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **lane database** *database-name* Switch(lane-config-database)#	Creates a named database for the LECS.
Step 2	Switch(lane-config-database)# **name** *elan-name1* **server-atm-address** *atm-address* [**index** *n*]	In the configuration database, binds the name of the first emulated LAN to the ATM address of the LES for that emulated LAN.
Step 3	Switch(lane-config-database)# **name** *elan-name1* **local-seg-id** *seg-num*	(Token Ring only.) In the configuration database, specifies the ring number for the first emulated LAN. (Catalyst 8510 MSR and LightStream 1010)

	Command	Purpose
Step 4	Switch(lane-config-database)# **name** *elan-name2* **server-atm-address** *atm-address* [**index** *n*]	In the configuration database, binds the name of the second emulated LAN to the ATM address of the LES. Repeat this step, providing a different emulated LAN name and an ATM address, for each additional emulated LAN in this switch cloud.
Step 5	Switch(lane-config-database)# **name** *elan-name2* **local-seg-id** *seg-num*	(Token Ring only) In the configuration database, specifies the ring number for the second emulated LAN. (Catalyst 8510 MSR and LightStream 1010) Repeat this step for each additional Token Ring emulated LAN.
Step 6	Switch(lane-config-database)# **default name** *elan-name1*	Specifies a default emulated LAN for LANE clients not explicitly bound to an emulated LAN. (Optional)

In Steps 2 and 4, enter the ATM address of the server for the specified emulated LAN, as noted in your worksheet and obtained in Displaying LANE Default Addresses, page 14-6.

To set up fault-tolerant operation, see Configuring Fault-Tolerant Operation, page 14-15.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Setting Up the Database for Restricted-Membership Emulated LANs

When you set up the database for restricted-membership emulated LANs, you create database entries that link the name of each emulated LAN to the ATM address of its *server*. However, you also must specify where the LANE clients are located. That is, for each restricted-membership emulated LAN, you provide a database entry that explicitly links the ATM address or MAC address of each *client* of that emulated LAN with the name of that emulated LAN.

When clients for the same restricted-membership emulated LAN are located in multiple routers, each client's ATM address or MAC address must be linked explicitly with the name of the emulated LAN. As a result, you must configure as many client entries (See Step 7 in the following procedure) as you have clients for emulated LANs in all the routers. Each client will have a different ATM address in the database entries.

To set up the configuration server for emulated LANs with restricted membership, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **lane database** *database-name* Switch(lane-config-database)#	Creates a named database for the LECS.
Step 2	Switch(lane-config-database)# **name** *elan-name1* **server-atm-address** *atm-address* [**index** *n*]	In the configuration database, binds the name of the first emulated LAN to the ATM address of the LES for that emulated LAN.

	Command	Purpose
Step 3	Switch(lane-config-database)# **name** *elan-name1* **local-seg-id** *seg-num*	(Token Ring only) In the configuration database, specifies the ring number for the first emulated LAN. (Catalyst 8510 MSR and LightStream 1010)
Step 4	Switch(lane-config-database)# **name** *elan-name2* **server-atm-address** *atm-address* [**index** *n*]	In the configuration database, binds the name of the second emulated LAN to the ATM address of the LES. Repeat this step, providing a different name and a different ATM address for each additional emulated LAN.
Step 5	Switch(lane-config-database)# **name** *elan-name2* **local-seg-id** *seg-num*	(Token Ring only.) In the configuration database, specifies the ring number for the second emulated LAN. (Catalyst 8510 MSR and LightStream 1010) Repeat this step for each additional Token Ring emulated LAN.
Step 6	Switch(lane-config-database)# **default-name** *elan-name1*	(Optional.) Specifies a default emulated LAN for LANE clients not explicitly bound to an emulated LAN.
Step 7	Switch(lane-config-database)# **client-atm-address** *atm-address-template* **name** *elan-name*	Adds a database entry associating a specific client's ATM address with a specific restricted-membership emulated LAN. Repeat this step for each client of each restricted-membership emulated LANs on this switch cloud, in each case specifying that client's ATM address and the name of the emulated LAN with which it is linked.

To set up fault-tolerant operation, see Configuring Fault-Tolerant Operation, page 14-15.

Enabling the Configuration Server

After you create the database entries appropriate to the type and to the membership conditions of the emulated LANs, you enable the configuration server on the selected ATM interface, router, or switch router, and specify that the configuration server's ATM address is to be computed automatically.

To enable the configuration server, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0**[**.***subinterface#* [**multipoint**]] Switch(config-if)#	If you are not currently configuring the interface, specifies the major ATM interface where the configuration server is located.
Step 2	Switch(config-if)# **lane config database** *database-name*	Links the configuration server's database name to the specified major interface, and enables the configuration server.
Step 3	Switch(config-if)# **lane config auto-config-atm-address**	Specifies that the configuration server's ATM address will be computed by our automatic method.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Note Since the 12.0(1a)W5(5b) release of the system software, addressing the interface on the Catalyst 8510 MSR and LightStream 1010 route processor has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. The old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

Setting Up LESs and Clients

For each device that participates in LANE, set up the necessary servers and clients for each emulated LAN; then display and record the server and client ATM addresses. Be sure to keep track of the router or switch router interface where the LECS will be located.

For one default emulated LAN, you must set up one set of servers: one as a primary server and the rest as backup servers for the same emulated LAN. For multiple emulated LANs, you can set up servers for another emulated LAN on a different subinterface or on the same interface of this router or switch router, or you can place the servers on a different router.

When you set up a server and BUS on a router, you can combine them with a client on the same subinterface, a client on a different subinterface, or no client at all on the router.

Where you put the clients is important, because any router with clients for multiple emulated LANs can route frames between those emulated LANs.

Note For Token Ring LANE environments that source-route bridge IP traffic to the ATM switch routers, multiring must be configured to enable Routing Information Field (RIF) packets. For an example, see Default Configuration for a Token Ring ELAN with IP Source Routing (Catalyst 8510 MSR and LightStream 1010), page 14-31.

Setting Up the Server, BUS, and a Client on a Subinterface

To set up the server, BUS, and (optionally) clients for an emulated LAN, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0.***subinterface#* [**multipoint**] Switch(config-subif)#	Specifies the subinterface for the first emulated LAN on this router.
Step 2	Switch(config-subif)# **lane server-bus** {**ethernet** | **tokenring**} *elan-name1*	Enables a LES and a LANE BUS for the first emulated LAN. (The **tokenring** option is not supported on the Catalyst 8540 MSR.)
Step 3	Switch(config-subif)# **lane client** {**ethernet** | **tokenring**} [*elan-name1*]	(Optional.) Enables a LANE client for the first emulated LAN. (The **tokenring** option is not supported on the Catalyst 8540 MSR.)
Step 4	Switch(config-subif)# **ip address** *ip-address mask*	Provides a protocol address for the client.

If the emulated LAN in Step 2 will have *restricted membership*, consider carefully whether you want to specify its name here. You will specify the name in the LECS's database when it is set up. However, if you link the client to an emulated LAN, and by some mistake it does not match the database entry linking the client to an emulated LAN, this client will not be allowed to join this or any other emulated LAN.

If you do decide to include the name of the emulated LAN linked to the client in Step 3 and later want to associate that client with a different emulated LAN, make the change in the configuration server's database before you make the change for the client on this subinterface.

Each emulated LAN is a separate subnetwork. In Step 4, make sure that the clients of the same emulated LAN are assigned protocol addresses on the same subnetwork, and that clients of different emulated LANs are assigned protocol addresses on different subnetworks.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Setting Up a Client on a Subinterface

On any given router or switch router, you can set up one client for one emulated LAN or multiple clients for multiple emulated LANs without a server and BUS. You can set up a client for a given emulated LAN on any routers you select to participate in that emulated LAN. Any router with clients for multiple emulated LANs can route packets among those emulated LANs.

To set up a client for an emulated LAN, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm 0.***subinterface#* [**multipoint**] Switch(config-subif)# or Switch(config)# **interface atm** *card/subcard/port.subinterface#* [**multipoint**] Switch(config-subif)#	Specifies the route processor subinterface number for an emulated LAN on this router. If you are using the optional ATM router module, specifies the ATM subinterface number. (Catalyst 8540 MSR)
Step 2	Switch(config-subif)# **ip address** *ip-address*	Provides a protocol address for the client on this subinterface.
Step 3	Switch(config-subif)# **lane client** {**ethernet** | **tokenring**} *elan-name1*	Enables a LANE client for the first emulated LAN. (The **tokenring** option is not supported on the Catalyst 8540 MSR.)

Note To route traffic between an emulated LAN and a Fast Ethernet (FE) or Gigabit Ethernet (GE) interface, you must configure the LANE client on an ATM router module interface rather than a route processor interface.

Each emulated LAN is a separate subnetwork. In Step 2, make sure that the clients of the same emulated LAN are assigned protocol addresses on the same subnetwork, and that clients of different emulated LANs are assigned protocol addresses on different subnetworks.

Note For Token Ring LANE environments that source-route bridge IP traffic to the ATM switch routers, multiring must be configured to enable Routing Information Field (RIF) packets. For an example, see Default Configuration for a Token Ring ELAN with IP Source Routing (Catalyst 8510 MSR and LightStream 1010), page 14-31.

Example (Catalyst 8540 MSR)

The following example shows how to configure a client for emulated LAN on an ATM router module subinterface:

```
Switch(config)# interface atm 10/0/1.1
Switch(config-if)# ip address 172.16.4.0 255.255.0.0
Switch(config-if)# lane client ethernet elan_1205
```

For additional examples of these commands, see LANE Configuration Examples, page 14-17.

Configuring a LAN Emulation Client on the ATM Switch Router

This section explains how to configure a LANE client connection from the ATM switch router in the headquarters building to the route processor interface (or optional ATM router module interface on the Catalyst 8540 MSR) of the ATM switch router.

Note This connection can be used for switch router management only.

A route processor (or optional ATM router module interface) configured as a LANE client allows you to configure the ATM switch router from a remote host.

Configuring an Ethernet LANE Client

To configure the route processor interface (or optional ATM router module interface on the Catalyst 8540 MSR) as an Ethernet LANE client on the ATM switch router, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm lecs-address** *lecsaddress*	Specifies the address to the LECS.
Step 2	Switch(config)# **interface atm 0**[**.***subinterface#* [**multipoint**]] Switch(config-if)# or Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***subinterface#* [**multipoint**]] Switch(config-if)#	Specifies the route processor interface. If you are using the optional ATM router module, specifies the ATM interface number. (Catalyst 8540 MSR)
Step 3	Switch(config-if)# **lane client-atm-address** *atm-address-template*	Specifies an ATM address, and overrides the automatic ATM address assignment for the LANE client.
Step 4	Switch(config-if)# **lane client ethernet** [*elan-name*]	Configures a LANE client on the specified subinterface.

Note To route traffic between an emulated LAN and a Fast Ethernet (FE) or Gigabit Ethernet (GE) interface, you must configure the LANE client on an ATM router module interface rather than a route processor interface.

Example

The following example shows how to specify the LANE configuration server (LECS) address and configure a LANE client on the route processor interface to emulate an Ethernet connection using the automatic ATM address assignment:

```
Switch(config)# atm lecs-address 47.0091.0000.0000.0000.0000.0000.0000.00
Switch(config)# interface atm 0
Switch(config-if)# lane client ethernet eng_elan
```

For additional examples of these commands, see LANE Configuration Examples, page 14-17. For LANE client configuration examples on ATM router module interfaces, see Chapter 25, "Configuring ATM Router Module Interfaces."

Configuring Fault-Tolerant Operation

The LANE simple server redundancy feature creates fault tolerance using standard LANE protocols and mechanisms. If a failure occurs on the LECS or on the LES/BUS, the emulated LAN can continue to operate using the services of a backup LES. This protocol is called the Simple Server Redundancy Protocol (SSRP).

For a detailed description of SSRP for LANE, refer to the *Guide to ATM Technology*.

Enabling Redundant LECSs and LES/BUSs

To enable fault tolerance, you enable multiple, redundant, and standby LECSs and multiple, redundant, and standby LES/BUSs. This allows the connected LANE components to obtain the global list of LECS addresses. Our LANE continues to operate seamlessly with other vendors' LANE components, but fault tolerance is not effective when other vendors' LANE components are present.

To configure multiple LES/BUSs for emulated LANs on the routers or switch routers, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **lane database** *database-name* Switch(lane-config-database)#	Creates a named database for the LECS.
Step 2	Switch(lane-config-database)# **name** *elan-name* **server-atm-address** *address* **index** *n*	Specifies redundant LES/BUSs, or simple server replication. Enter the command for each LES address for the same emulated LAN. The index determines the priority. The 0 is the highest priority.
Step 3	Switch(lane-config-database)# **lane client** {**ethernet** | **tokenring**} *elan-name*	Enables a LANE client for the first emulated LAN. (The **tokenring** option is not supported on the Catalyst 8540 MSR.)

Server redundancy guards against the failure of the hardware on which LES components are running. This includes all the ATM interface cards in our routers and Catalyst switches. Fault tolerance is not effective for ATM network or switch router failures.

Caution For server redundancy to work correctly, all ATM switch routers must have identical lists of the global LECS addresses, in the identical priority order. The operating LECSs must use exactly the same configuration database.

Load the configuration table data using the **configure network** command. This method minimizes errors and enables the database to be maintained centrally in one place.

For examples of these commands, see LANE Configuration Examples, page 14-17.

Implementation Considerations

For important considerations when implementing SSRP, refer to the LANE discussion in the *Guide to ATM Technology*.

Caution You can override the LECS address on any subinterface by using the **lane auto-config-atm-address**, **lane fixed-config-atm-address**, and **lane config-atm-address** commands. When you perform an override using one of these commands, however, fault-tolerant operation cannot be guaranteed. To avoid affecting the fault-tolerant operation, do not override any LECS, LES, or BUS addresses.

Monitoring and Maintaining the LANE Components

After configuring LANE components on an interface or any of its subinterfaces, on a specified subinterface, or on an emulated LAN, you can display their status. To show LANE information, use the following EXEC commands:

Command	Purpose
show lane [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-virtual channel connection LANE information for all the LANE components and emulated LANs configured on an interface or any of its subinterfaces.
show lane bus [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-VCC LANE information for the BUS configured on any subinterface or emulated LAN.
show lane client [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-VCC LANE information for all LANE clients configured on any subinterface or emulated LAN.
show lane config [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*]]	Displays the global and per-VCC LANE information for the configuration server configured on any interface.
show lane database [*name*]	Displays the LECS's database.
show lane le-arp [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*] | **name** *elan-name*]	Displays the LANE ARP table of the LANE client configured on the specified subinterface or emulated LAN.
show lane server [**interface atm** *card***/***subcard***/***port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-VCC LANE information for the LES configured on a specified subinterface or emulated LAN.

LANE Configuration Examples

The examples in the following sections illustrate how to configure LANE for the following cases:

- Default configuration for a single emulated LAN with a LANE client on the ATM switch router
- Default configuration for a single emulated LAN with a backup LECS and LES on the ATM switch router
- Default configuration for a single emulated Token Ring LAN using IP source routing across a source-route bridged network with a LANE client on the ATM switch router

All examples use the automatic ATM address assignment method described in Automatic ATM Addressing and Address Templates for LANE Components, page 14-3.

These examples show the LANE configurations, not the process of determining the ATM addresses and entering them.

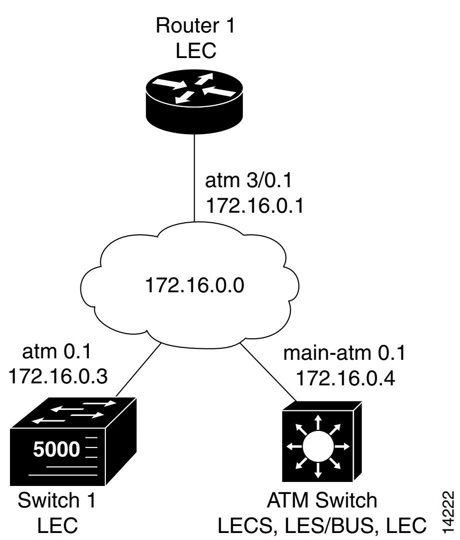
Note For LANE client configuration examples on ATM router module interfaces, see Chapter 25, "Configuring ATM Router Module Interfaces."

Default Configuration for a Single Emulated LAN

The following examples show how to configure one Cisco 7505 router, one ATM switch, and one Catalyst 5500 switch for a single emulated LAN. Configurations for both Ethernet and Token Ring emulated LANs are shown.

The ATM switch contains the LECS, LES, BUS, and an LEC. The router and Catalyst 5500 switch each contain an LEC for the emulated LAN. This example uses all LANE default settings. For example, it does not explicitly set ATM addresses for the different LANE components that are colocated on the ATM switch. Membership in this emulated LAN is not restricted (see Figure 14-3).

Figure 14-3 Single Emulated LAN Example Network



Ethernet Example

ATM Switch

```
ATM_Switch# show lane default-atm-addresses
interface ATM13/0/0:
LANE Client:        47.00918100000000E04FACB401.00E04FACB402.**
LANE Server:        47.00918100000000E04FACB401.00E04FACB403.**
LANE Bus:           47.00918100000000E04FACB401.00E04FACB404.**
LANE Config Server: 47.00918100000000E04FACB401.00E04FACB405.00
note: ** is the subinterface number byte in hex

ATM_Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM_Switch(config)# atm lecs-address-default 47.00918100000000E04FACB401.00E04FACB405.00
ATM_Switch(config)# end
ATM_Switch#
ATM_Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
ATM_Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM_Switch(config)# lane database eng_dbase
ATM_Switch(lane-config-database)# name eng_elan server-atm-address
47.00918100000000E04FACB401.00E04FACB403.01
ATM_Switch(lane-config-database)# default-name eng_elan
ATM_Switch(lane-config-database)# end
ATM_Switch# show lane database

LANE Config Server database table 'eng_dbase'
default elan: eng_elan
elan 'eng_elan': un-restricted
  server 47.00918100000000E04FACB401.00E04FACB403.01 (prio 0)

ATM_Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM_Switch(config)# interface atm 0
ATM_Switch(config-if)# lane config database eng_dbase
ATM_Switch(config-if)# lane config auto-config-atm-address
ATM_Switch(config-if)# exit
ATM_Switch(config)# end
ATM_Switch# show lane config
LE Config Server ATM13/0/0 config table: eng_dbase
Admin: up  State: operational
LECS Mastership State: active master
list of global LECS addresses (42 seconds to update):
47.00918100000000E04FACB401.00E04FACB405.00  <-------- me
ATM Address of this LECS: 47.00918100000000E04FACB401.00E04FACB405.00 (auto)
cumulative total number of unrecognized packets received so far: 0
cumulative total number of config requests received so far: 0
cumulative total number of config failures so far: 0

ATM_Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM_Switch(config)# interface atm 0.1 multipoint
ATM_Switch(config-subif)# lane server-bus ethernet eng_elan
ATM_Switch(config-subif)# ip address 172.16.0.4 255.255.0.0
ATM_Switch(config-subif)# end
```

```
ATM_Switch# show lane
LE Config Server ATM13/0/0 config table: eng_dbase
Admin: up  State: operational
LECS Mastership State: active master
list of global LECS addresses (46 seconds to update):
47.00918100000000E04FACB401.00E04FACB405.00  <-------- me
ATM Address of this LECS: 47.00918100000000E04FACB401.00E04FACB405.00 (auto)
 vcd  rxCnt  txCnt  callingParty
  82      0      0  47.00918100000000E04FACB401.00E04FACB403.01 LES eng_elan 0 active
cumulative total number of unrecognized packets received so far: 0
cumulative total number of config requests received so far: 0
cumulative total number of config failures so far: 0

LE Server ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
type: ethernet         Max Frame Size: 1516
ATM address: 47.00918100000000E04FACB401.00E04FACB403.01
LECS used: 47.00918100000000E04FACB401.00E04FACB405.00 connected, vcd 81

LE BUS ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
type: ethernet         Max Frame Size: 1516
ATM address: 47.00918100000000E04FACB401.00E04FACB404.01

ATM_Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM_Switch(config)# interface atm 0.1 multipoint
ATM_Switch(config-subif)# lane client ethernet eng_elan
ATM_Switch(config-subif)# end
ATM_Switch# show lane client
LE Client ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
Client ID: 1                 LEC up for 30 seconds
ELAN ID: 0
Join Attempt: 1
HW Address: 00e0.4fac.b402   Type: ethernetMax Frame Size: 1516
ATM Address: 47.00918100000000E04FACB401.00E04FACB402.01

 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  47.00918100000000E04FACB401.00E04FACB405.00
  87         1         2  direct     47.00918100000000E04FACB401.00E04FACB403.01
  90         1         0  distribute 47.00918100000000E04FACB401.00E04FACB403.01
  91         0         1  send       47.00918100000000E04FACB401.00E04FACB404.01
  94         0         0  forward    47.00918100000000E04FACB401.00E04FACB404.01

ATM_Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
ATM_Switch#
```

Note The ELAN ID shown in the above **show lane client** command display is relevant only for LANE version 2-capable clients. The ELAN ID is configured with either the **name** *elan-name* command in database configuration mode, or the **lane server-bus** command in subinterface configuration mode.

Router 1

```
router1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
router1(config)# interface atm 3/0
router1(config-if)# atm pvc 1 0 5 qsaal
router1(config-if)# atm pvc 2 0 16 ilmi
router1(config-if)# interface atm 3/0.1
router1(config-subif)# ip address 172.16.0.1 255.255.0.0
router1(config-subif)# lane client ethernet eng_elan
router1(config-subif)# end
router1# more system:running-config
Building configuration...

Current configuration:
!
version 11.1

<Information deleted>

!
interface ATM3/0
 no ip address
 atm pvc 1 0 5 qsaal
 atm pvc 2 0 16 ilmi
!
interface ATM3/0.1 midpoint
 lane client ethernet eng_elan
!

<information deleted>

!
end

router1# show interfaces atm 3/0.1
ATM3/0.1 is up, line protocol is up
 Hardware is Caxias ATM
  MTU 1500 bytes, BW 156250 Kbit, DLY 80 usec, rely 255/255, load 1/255
  Encapsulation ATM-LANE
  ARP type: ARPA, ARP Timeout 04:00:00
router1#
```

Catalyst 5500 Switch 1

```
Switch1> session 4
Trying ATM-4...
Connected to ATM-4.
Escape character is '^]'.
ATM> enable
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0
ATM(config-if)# lane server-bus ethernet eng_elan
ATM(config-if)# end
ATM# copy system:running-config nvram:startup-config
Building configuration...
[OK]
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0
ATM(config-if)# atm pvc 1 0 5 qsaal
ATM(config-if)# atm pvc 2 0 16 ilmi
ATM(config-if)# end
ATM#
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0.1 multipoint
ATM(config-subif)# lane client ethernet 1 eng_elan
ATM(config-subif)# end
ATM# show lane client
LE Client ATM0.1  ELAN name: eng_elan  Admin: up  State: operational
Client ID: 3                 LEC up for 24 seconds
Join Attempt: 11
HW Address: 00e0.4fac.b030   Type: ethernetMax Frame Size: 1516       VLANID: 1

ATM Address: 47.00918100000000E04FACB401.00E04FACB030.01

 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  47.00918100000000E04FACB401.00E04FACB405.00
  27         1        14  direct     47.00918100000000E04FACB401.00E04FACB403.01
  29        13         0  distribute 47.00918100000000E04FACB401.00E04FACB403.01
  30         0        15  send       47.00918100000000E04FACB401.00E04FACB404.01
  31         0         0  forward    47.00918100000000E04FACB401.00E04FACB404.01

ATM# copy system:running-config nvram:startup-config
Building configuration...
[OK]
ATM#
```

Confirming Connectivity between the ATM Switch and Other LANE Members

The following example shows how to use the **show lane** and **ping** commands to confirm the connection between the ATM switch, routers, and LAN switches.

ATM Switch

```
Switch# show lane
LE Config Server ATM13/0/0 config table: eng_dbase
Admin: up  State: operational
LECS Mastership State: active master
list of global LECS addresses (31 seconds to update):
47.00918100000000E04FACB401.00E04FACB405.00  <-------- me
ATM Address of this LECS: 47.00918100000000E04FACB401.00E04FACB405.00 (auto)
 vcd  rxCnt  txCnt  callingParty
  82      2      2  47.00918100000000E04FACB401.00E04FACB403.01 LES eng_elan 0 active
cumulative total number of unrecognized packets received so far: 0
cumulative total number of config requests received so far: 4
cumulative total number of config failures so far: 0

LE Server ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
type: ethernet         Max Frame Size: 1516
ATM address: 47.00918100000000E04FACB401.00E04FACB403.01
LECS used: 47.00918100000000E04FACB401.00E04FACB405.00 connected, vcd 81
control distribute: vcd 89, 2 members, 2 packets

proxy/ (ST: Init, Conn, Waiting, Adding, Joined, Operational, Reject, Term)
lecid ST vcd    pkts Hardware Addr  ATM Address
   1  O   88       2 00e0.4fac.b402 47.00918100000000E04FACB401.00E04FACB402.01
   2  O   96       2 0080.1c93.8060 47.00918100000000E04FACB401.00801C938060.01

LE BUS ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
type: ethernet         Max Frame Size: 1516
ATM address: 47.00918100000000E04FACB401.00E04FACB404.01
data forward: vcd 93, 2 members, 95 packets, 0 unicasts

lecid  vcd     pkts   ATM Address
    1   92       95 47.00918100000000E04FACB401.00E04FACB402.01
    2   97       42 47.00918100000000E04FACB401.00801C938060.01

LE Client ATM13/0/0.1  ELAN name: eng_elan  Admin: up  State: operational
Client ID: 1                 LEC up for 1 hour 34 minutes 46 seconds
ELAN ID: 0
Join Attempt: 1
HW Address: 00e0.4fac.b402   Type: ethernetMax Frame Size: 1516
ATM Address: 47.00918100000000E04FACB401.00E04FACB402.01

 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  47.00918100000000E04FACB401.00E04FACB405.00
  87         1         2  direct     47.00918100000000E04FACB401.00E04FACB403.01
  90         2         0  distribute 47.00918100000000E04FACB401.00E04FACB403.01
  91         0        95  send       47.00918100000000E04FACB401.00E04FACB404.01
  94        42         0  forward    47.00918100000000E04FACB401.00E04FACB404.01

ATM_Switch# ping 172.16.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
ATM_Switch# ping 172.16.0.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
```

Token Ring Example (Catalyst 8510 MSR and LightStream 1010)

In this Token Ring example, the Cisco 7505 router contains the LECS, LES, BUS, and an LEC. The ATM switch router and Catalyst 5500 Fast Ethernet switch each contain an LEC for the emulated LAN. This example uses all LANE default settings. For example, it does not explicitly set ATM addresses for the different LANE components that are co-located on the router. Membership in this emulated LAN is not restricted.

Router 1

```
router1# show lane default-atm-addresses
interface ATM3/0:
LANE Client:        47.00918100000000603E7B2001.00000C407572.**
LANE Server:        47.00918100000000603E7B2001.00000C407573.**
LANE Bus:           47.00918100000000603E7B2001.00000C407574.**
LANE Config Server: 47.00918100000000603E7B2001.00000C407575.00
note: ** is the subinterface number byte in hex
```

ATM Switch

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00000C407575.00
Switch(config)# end
Switch#
```

Router 1

```
router1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router1(config)# lane database eng_dbase
router1(lane-config-database)# name eng_elan server-atm-address
47.00918100000000603E7B2001.00000C407573.01
router1(lane-config-database)# name eng_elan local-seg-id 2048
router1(lane-config-database)# default-name eng_elan
router1(lane-config-database)# exit
router1(config)# interface atm0
router1(config-if)# atm pvc 1 0 5 qsaal
router1(config-if)# atm pvc 2 0 16 ilmi
router1(config-if)# lane config auto-config-atm-address
router1(config-if)# lane config database eng_dbase
router1(config-if)#
%LANE-5-UPDOWN: ATM0 database example1: LE Config Server (LECS) changed state to up
router1(config-if)# interface atm3/0.1
router1(config-subif)# ip address 172.16.0.1 255.255.0.0
router1(config-subif)# lane server-bus tokenring eng_elan
router1(config-subif)# lane client tokenring eng_elan
router1(config-subif)#
%LANE-5-UPDOWN: ATM0.1 elan eng: LE Client changed state to up
router1(config-subif)# end
router1#
```

Catalyst 5000 Switch 1

```
Switch1> session 4
Trying ATM-4...
Connected to ATM-4.
Escape character is '^]'.
ATM> enable
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0
ATM(config-if)# lane server-bus tokenring eng_elan
ATM(config-if)# end
ATM# copy system:running-config nvram:startup-config
Building configuration...
[OK]
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0
ATM(config-if)# atm pvc 1 0 5 qsaal
ATM(config-if)# atm pvc 2 0 16 ilmi
ATM(config-if)# end
ATM#
ATM# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ATM(config)# interface atm 0.1 multipoint
ATM(config-subif)# lane client tokenring 1 eng_elan
ATM(config-subif)# end
ATM#
```

ATM Switch

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0.1 multipoint
Switch(config-subif)# ip address 172.16.0.4 255.255.0.0
Switch(config-subif)# lane client tokenring eng_elan
Switch(config-subif)#
%LANE-5-UPDOWN: ATM13/0/0.1 elan : LE Client changed state to up
Switch(config-subif)# end
Switch#
```

Confirming Connectivity between the ATM switch and the Routers

The following example shows how to use the **ping** command to confirm the connection between the ATM switch and routers:

```
ATM_Switch# ping 172.16.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
ATM_Switch# ping 172.16.0.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms
```

Displaying the LANE Client Configuration on the ATM switch

The following example shows the **show lane client** command display for the Ethernet LANE client in the ATM switch:

```
ATM_Switch# show lane client
LE Client ATM13/0/0.1  ELAN name: eng  Admin: up  State: operational
Client ID: 3                 LEC up for 4 minutes 58 seconds
Join Attempt: 1
HW Address: 0060.3e7b.2002   Type: ethernet             Max Frame Size: 1516
ATM Address: 47.00918100000000603E7B2001.00603E7B2002.01

 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  47.00918100000000603E7B2001.00000C407575.00
  52         1         4  direct     47.00918100000000603E7B2001.00000C407573.01
  53         9         0  distribute 47.00918100000000603E7B2001.00000C407573.01
  54         0        13  send       47.00918100000000603E7B2001.00000C407574.01
  55        19         0  forward    47.00918100000000603E7B2001.00000C407574.01
  56        11        10  data       47.00918100000000603E7B2001.00000C407572.01
  57         6         5  data       47.00918100000000603E7B2001.00000C407C02.02
```

The following example shows the **show lane client** command display for the Token Ring LANE client in the ATM switch router:

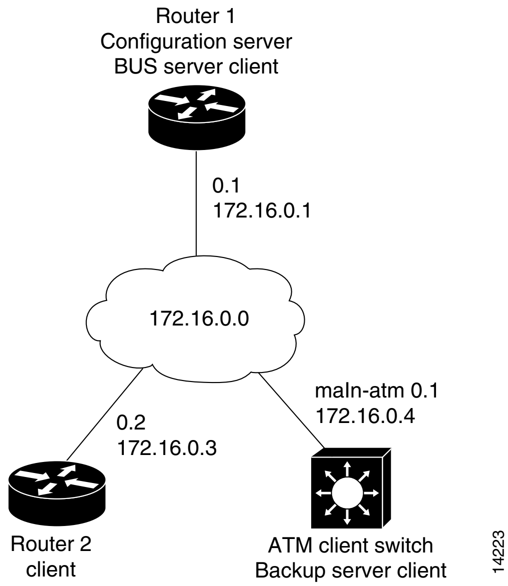
```
ATM_Switch# show lane client
LE Client ATM13/0/0.1  ELAN name: eng  Admin: up  State: operational
Client ID: 3                 LEC up for 4 minutes 58 seconds
Join Attempt: 1
HW Address: 0060.3e7b.2002   Type: token ring           Max Frame Size: 4544
ATM Address: 47.00918100000000603E7B2001.00603E7B2002.01

 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  47.00918100000000603E7B2001.00000C407575.00
  52         1         4  direct     47.00918100000000603E7B2001.00000C407573.01
  53         9         0  distribute 47.00918100000000603E7B2001.00000C407573.01
  54         0        13  send       47.00918100000000603E7B2001.00000C407574.01
  55        19         0  forward    47.00918100000000603E7B2001.00000C407574.01
  56        11        10  data       47.00918100000000603E7B2001.00000C407572.01
  57         6         5  data       47.00918100000000603E7B2001.00000C407C02.02
```

Default Configuration for a Single Emulated LAN with Backup LECS and LES on the ATM Switch Router

The following examples show how to configure two Cisco 4500 routers and one ATM switch router for one emulated LAN with fault tolerance. Configurations for both Ethernet and Token Ring emulated LANs are shown.

Router 1 contains the LECS, LES, BUS, and an LEC. Router 2 contains only an LEC. The ATM switch router contains the backup LECS and the backup LES for this emulated LAN, along with another LEC (see Figure 14-4).

Figure 14-4 Single Emulated LAN with Backup LANE Example Network



This example shows how to accept all default settings provided. For example, it does not explicitly set ATM addresses for the different LANE components that are also on the router. Membership in this emulated LAN is not restricted.

Ethernet Example

Router 1

```
router1# show lane default-atm-addresses
interface ATM0:
LANE Client:        47.00918100000000603E7B2001.00000C407572.**
LANE Server:        47.00918100000000603E7B2001.00000C407573.**
LANE Bus:           47.00918100000000603E7B2001.00000C407574.**
LANE Config Server: 47.00918100000000603E7B2001.00000C407575.00
note: ** is the subinterface number byte in hex
```

ATM Switch Router

```
Switch# show lane default-atm-address
interface ATM2/0/0:
LANE Client:        47.00918100000000603E7B2001.00603E7B2002.**
LANE Server:        47.00918100000000603E7B2001.00603E7B2003.**
LANE Bus:           47.00918100000000603E7B2001.00603E7B2004.**
LANE Config Server: 47.00918100000000603E7B2001.00603E7B2005.00
note: ** is the subinterface number byte in hex

Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00000C407575.00
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00603E7B2005.00
Switch(config)# end
Switch#
```

Router 1

```
router1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router1(config)# lane database example1
router1(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00000C407573.01
router1(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00603E7B2003.01
router1(lane-config-database)# default-name eng
router1(lane-config-database)# exit
router1(config)# interface atm 3/0
router1(config-if)# atm pvc 1 0 5 qsaal
router1(config-if)# atm pvc 2 0 16 ilmi
router1(config-if)# lane config auto-config-atm-address
router1(config-if)# lane config database example1
router1(config-if)#
%LANE-5-UPDOWN: ATM0 database example1: LE Config Server (LECS) changed state to up
router1(config-if)# interface atm 3/0.1
router1(config-subif)# ip address 172.16.0.1 255.255.0.0
router1(config-subif)# lane server-bus ethernet eng
router1(config-subif)# lane client ethernet eng
router1(config-subif)#
%LANE-5-UPDOWN: ATM0.1 elan eng: LE Client changed state to up
router1(config-subif)# end
router1#
```

ATM Switch Router

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# lane database example1_backup
Switch(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00000C407573.01
Switch(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00603E7B2003.01
Switch(lane-config-database)# default-name eng
Switch(lane-config-database)# exit
Switch(config)# interface atm 0
Switch(config-if)# lane config auto-config-atm-address
Switch(config-if)# lane config database example1_backup
Switch(config-if)#
%LANE-5-UPDOWN: ATM2/0/0 database example1_backup: LE Config Server (LECS) changed state
to up
%LANE-6-LECS_INFO: ATM2/0/0: started listening on the well known LECS address
%LANE-6-LECS_INFO: LECS on interface ATM2/0/0 became a BACKUP
%LANE-6-LECS_INFO: ATM2/0/0: stopped listening on the well known LECS address
Switch(config-if)# interface atm 0.1 multipoint
Switch(config-subif)# ip address 172.16.0.4 255.255.0.0
Switch(config-subif)# lane server-bus ethernet eng
Switch(config-subif)#
%LANE-5-UPDOWN: ATM2/0/0.1 elan eng: LE Server/BUS changed state to up
Switch(config-subif)# lane client ethernet eng
Switch(config-subif)#
%LANE-5-UPDOWN: ATM2/0/0.1 elan eng: LE Client changed state to up
Switch(config-subif)# end
Switch#
```

Router 2

```
router2# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router2(config)# interface atm 3/0
router2(config-if)# atm pvc 1 0 5 qsaal
router2(config-if)# atm pvc 2 0 16 ilmi
router2(config-if)# interface atm 3/0.2
router2(config-subif)# ip address 172.16.0.3 255.255.0.0
router2(config-subif)# lane client ethernet eng
router2(config-subif)#
%LANE-5-UPDOWN: ATM0.2 elan : LE Client changed state to up
router2(config-subif)# end
router2#
```

Token Ring Example (Catalyst 8510 MSR and LightStream 1010)

Router 1

```
router1# show lane default-atm-addresses
interface ATM3/0:
LANE Client:        47.00918100000000603E7B2001.00000C407572.**
LANE Server:        47.00918100000000603E7B2001.00000C407573.**
LANE Bus:           47.00918100000000603E7B2001.00000C407574.**
LANE Config Server: 47.00918100000000603E7B2001.00000C407575.00
note: ** is the subinterface number byte in hex
```

ATM Switch

```
Switch# show lane default-atm-address
interface ATM2/0/0:
LANE Client:        47.00918100000000603E7B2001.00603E7B2002.**
LANE Server:        47.00918100000000603E7B2001.00603E7B2003.**
LANE Bus:           47.00918100000000603E7B2001.00603E7B2004.**
LANE Config Server: 47.00918100000000603E7B2001.00603E7B2005.00
note: ** is the subinterface number byte in hex

Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00000C407575.00
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00603E7B2005.00
Switch(config)# end
Switch#
```

Router 1

```
router1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router1(config)# lane database example1
router1(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00000C407573.01
router1(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00603E7B2003.01
router1(lane-config-database)# name eng local-seg-id 2048
router1(lane-config-database)# default-name eng
router1(lane-config-database)# exit
router1(config)# interface atm 3/0
router1(config-if)# atm pvc 1 0 5 qsaal
router1(config-if)# atm pvc 2 0 16 ilmi
router1(config-if)# lane config auto-config-atm-address
router1(config-if)# lane config database example1
router1(config-if)#
%LANE-5-UPDOWN: ATM0 database example1: LE Config Server (LECS) changed state to up
router1(config-if)# interface atm 3/0.1
router1(config-subif)# ip address 172.16.0.1 255.255.0.0
router1(config-subif)# lane server-bus tokenring eng
router1(config-subif)# lane client tokenring eng
router1(config-subif)#
%LANE-5-UPDOWN: ATM0.1 elan eng: LE Client changed state to up
router1(config-subif)# end
router1#
```

ATM Switch

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# lane database example1_backup
Switch(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00000C407573.01
Switch(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00603E7B2003.01
Switch(lane-config-database)# name eng local-seg-id 2048
Switch(lane-config-database)# default-name eng
Switch(lane-config-database)# exit
Switch(config)# interface atm 0
Switch(config-if)# lane config auto-config-atm-address
Switch(config-if)# lane config database example1_backup
Switch(config-if)#
%LANE-5-UPDOWN: ATM2/0/0 database example1_backup: LE Config Server (LECS) changed state
to up
%LANE-6-LECS_INFO: ATM2/0/0: started listening on the well known LECS address
%LANE-6-LECS_INFO: LECS on interface ATM2/0/0 became a BACKUP
%LANE-6-LECS_INFO: ATM2/0/0: stopped listening on the well known LECS address
Switch(config-if)# interface atm 0.1 multipoint
Switch(config-subif)# ip address 172.16.0.4 255.255.0.0
Switch(config-subif)# lane server-bus tokenring eng
Switch(config-subif)#
%LANE-5-UPDOWN: ATM2/0/0.1 elan eng: LE Server/BUS changed state to up
Switch(config-subif)# lane client tokenring eng
Switch(config-subif)#
%LANE-5-UPDOWN: ATM2/0/0.1 elan eng: LE Client changed state to up
Switch(config-subif)# end
Switch#
```

Router 2

```
router2# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router2(config)# interface atm 3/0
router2(config-if)# atm pvc 1 0 5 qsaal
router2(config-if)# atm pvc 2 0 16 ilmi
router2(config-if)# interface atm 3/0.2
router2(config-subif)# ip address 172.16.0.3 255.255.0.0
router2(config-subif)# lane client tokenring eng
router2(config-subif)#
%LANE-5-UPDOWN: ATM0.2 elan : LE Client changed state to up
router2(config-subif)# end
router2#
```

Displaying the LECS Configuration on the ATM Switch Router

The following example shows the **show lane config** command display for the LECS (Ethernet and Token Ring):

```
Switch# show lane config
LE Config Server ATM2/0/0 config table: example1_backup
Admin: up  State: operational
LECS Mastership State: backup
list of global LECS addresses (45 seconds to update):
47.00918100000000603E7B2001.00000C407575.00 incoming call (vcd 88)
47.00918100000000603E7B2001.00603E7B2005.00  <-------- me
ATM Address of this LECS: 47.00918100000000603E7B2001.00603E7B2005.00 (auto)
 vcd  rxCnt  txCnt  callingParty
  88      0      0  47.00918100000000603E7B2001.00000C407575.00 LECS
cumulative total number of unrecognized packets received so far: 0
cumulative total number of config requests received so far: 0
cumulative total number of config failures so far: 0
```

Displaying the LES Configuration on the ATM Switch Router

The following example shows the **show lane server** command display for the Ethernet LES:

```
Switch# show lane server
LE Server ATM2/0/0.1  ELAN name: eng  Admin: up  State: operational
type: ethernet         Max Frame Size: 1516
ATM address: 47.00918100000000603E7B2001.00603E7B2003.01
LECS used: 47.00918100000000603E7B2001.00000C407575.00 connected, vcd 95
```

The following example shows the **show lane server** command display for the Token Ring LANE server:

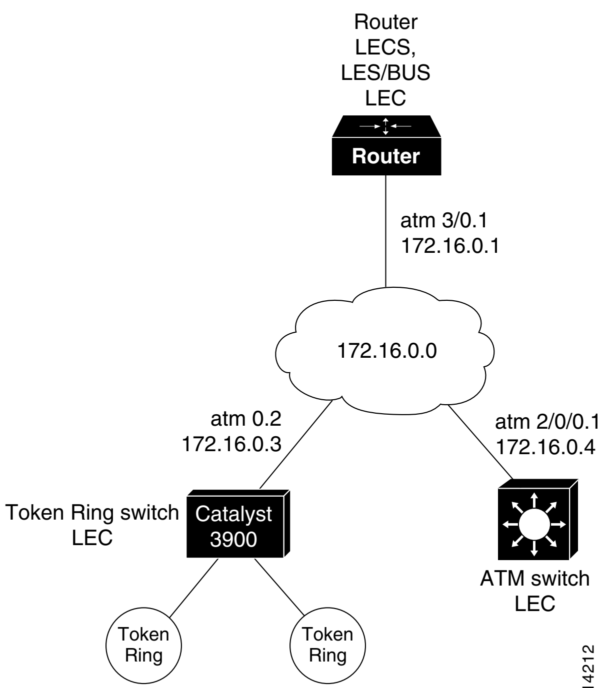
```
Switch# show lane server
LE Server ATM2/0/0.1  ELAN name: eng  Admin: up  State: operational
type: token ring         Max Frame Size: 4544      Segment ID: 2048
ATM address: 47.00918100000000603E7B2001.00603E7B2003.01
LECS used: 47.00918100000000603E7B2001.00000C407575.00 connected, vcd 95
```

Default Configuration for a Token Ring ELAN with IP Source Routing (Catalyst 8510 MSR and LightStream 1010)

The following example shows how to configure a single emulated Token Ring LAN using a Cisco 4500 router and an ATM switch with IP source routing across a source-route bridged network. In this example, the emulated Token Ring LAN is source-route bridged to two physical Token Rings.

The router contains the LECS, LES, BUS, and an LEC. Both the ATM switch and Token Ring switch contain an LEC for the emulated LAN. This example uses all LANE default settings. For example, it does not explicitly set ATM addresses for the different LANE components that are colocated on the router. Membership in this emulated LAN is not restricted (see Figure 14-5).

Figure 14-5 Single Emulated Token Ring LAN with Token Ring Switch



Router

```
router# show lane default-atm-addresses
interface ATM0:
LANE Client:        47.00918100000000603E7B2001.00000C407572.**
LANE Server:        47.00918100000000603E7B2001.00000C407573.**
LANE Bus:           47.00918100000000603E7B2001.00000C407574.**
LANE Config Server: 47.00918100000000603E7B2001.00000C407575.00
note: ** is the subinterface number byte in hex
```

ATM Switch

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# atm lecs-address-default 47.00918100000000603E7B2001.00000C407575.00
Switch(config)# end
Switch#
```

Router

```
router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
router(config)# lane database example1
router(lane-config-database)# name eng server-atm-address
47.00918100000000603E7B2001.00000C407573.01
router(lane-config-database)# name eng local-seg-id 2048
router(lane-config-database)# default-name eng
router(lane-config-database)# exit
router(config)# interface atm 3/0
router(config-if)# atm pvc 1 0 5 qsaal
router(config-if)# atm pvc 2 0 16 ilmi
router(config-if)# lane config auto-config-atm-address
router(config-if)# lane config database example1
router(config-if)#
%LANE-5-UPDOWN: ATM0 database example1: LE Config Server (LECS) changed state to up
router(config-if)# interface atm 3/0.1
router(config-subif)# ip address 172.16.0.1 255.255.0.0
router(config-subif)# lane server-bus tokenring eng
router(config-subif)# lane client tokenring eng
router(config-subif)#
%LANE-5-UPDOWN: ATM0.1 elan eng: LE Client changed state to up
router(config-subif)# end
router#
```

ATM Switch

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0.1 multipoint
Switch(config-subif)# ip address 172.16.0.4 255.255.0.0
Switch(config-subif)# lane client tokenring eng
Switch(config-subif)# multiring ip
Switch(config-subif)#
%LANE-5-UPDOWN: ATM2/0/0.1 elan : LE Client changed state to up
Switch(config-subif)# end
Switch#
```

Configuring ATM Accounting, RMON, and SNMP

This chapter describes the ATM accounting, Remote Monitoring (RMON), and SNMP features used with the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Note The ATM accounting and ATM RMON features both require a minimum of 32 MB of dynamic random access memory (DRAM) installed on the multiservice route processor. If you want to run both ATM accounting and ATM RMON features together, you must have 64 MB of DRAM.

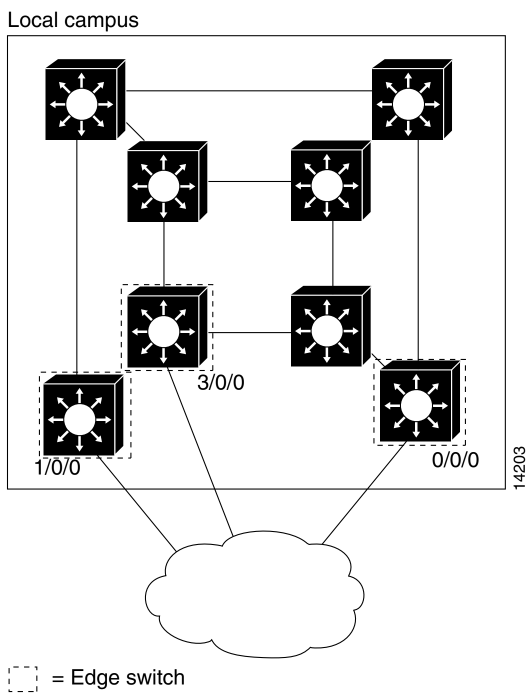
Configuring ATM Accounting

The following sections describe the process used to enable and configure the ATM accounting feature on the ATM switch router:

ATM Accounting Overview

The ATM accounting feature provides accounting and billing services for virtual circuits (VCs) used on the ATM switch router. You enable ATM accounting on an edge switch to monitor call setup and traffic activity. A specific interface can be configured to monitor either incoming or outgoing or incoming and outgoing VC use. Figure 15-1 shows a typical ATM accounting environment.

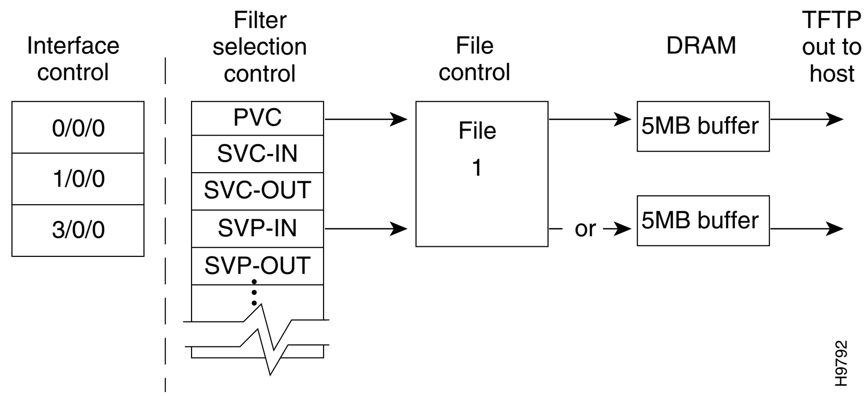
Figure 15-1 ATM Accounting Environment



The edge switches, connected to the exterior Internet, are connections that require monitoring for accounting and billing purposes.

Switching speeds and number of VCs supported by the ATM switch router while monitoring virtual circuit use for accounting purposes can cause the amount of data to be gathered to reach the megabyte range. With such a large amount of data in the ATM accounting files, using traditional Simple Network Management Protocol (SNMP) methods of data retrieval is not feasible. You can store the collected accounting information in a file that you can retrieve using a file transfer protocol. SNMP provides management control of the selection and collection of accounting data. Figure 15-2 shows an interface, filtering, and file configuration example.

Figure 15-2 Interface and File Management for ATM Accounting



A file used for data collection actually corresponds to two memory buffers on the multiservice route processor. One buffer is actively saving data, while the second is passive and ready to have its data either retrieved using Trivial File Transport Protocol (TFTP) or overwritten when the currently active file reaches its maximum capacity. Alternatively, the file can be written to a remotely connected PC over a TCP connection.

Configuring Global ATM Accounting

The ATM accounting feature must be enabled to start gathering ATM accounting virtual circuit call setup and use data. The ATM accounting feature runs in the background and captures configured accounting data for VC changes such as calling party, called party, or start time and connection type information for specific interfaces to a file.

Caution Enabling ATM accounting could slow the basic operation of the ATM switch router.

Note Even when ATM accounting is disabled globally, other ATM accounting commands, both global and for individual interfaces, remain in the configuration file.

To enable the ATM accounting feature, use the following command in global configuration mode:

Command	Purpose
atm accounting enable	Enables ATM accounting for the ATM switch router.

Displaying the ATM Accounting Configuration

To display the ATM accounting status, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the ATM accounting status.

Enabling ATM Accounting on an Interface

After you enable ATM accounting, you must configure specific ingress or egress interfaces, usually on edge switches connected to the external network, to start gathering the ATM accounting data.

To enable ATM accounting on a specific interface, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-line)# **privilege level** *number*	Configures the default privilege level.

Example

The following example shows how to enable ATM accounting on ATM interface 1/0/3:

```
Switch(config)# interface atm 1/0/3
Switch(config-if)# atm accounting
```

Displaying the ATM Accounting Interface Configuration

To display the ATM accounting status, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the ATM accounting status.

Example

The following display shows that ATM accounting is enabled on ATM interface 1/0/3:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!

<information deleted>

!
interface ATM1/0/3
 no keepalive
 atm accounting
!
<information deleted>
```

Configuring the ATM Accounting Selection Table

The ATM accounting selection table determines the connection data to be gathered from the ATM switch router. To configure the ATM accounting selection entries, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm accounting selection** *index* Switch(config-acct-sel)#	Specifies the ATM accounting selection index number and changes to accounting selection mode.
Step 2	Switch(config-acct-sel)# **default** [**connection-type** | **list**]	Resets the ATM accounting selection table configuration to the default.
Step 3	Switch(config-acct-sel)# **connection-types** [**pvc** | **pvp** | **spvc-originator** | **spvc-target** | **spvp-originator** | **spvp-target** | **svc-in** | **svc-out** | **svp-in** | **svp-out**]	Specifies the connection type(s) for which you want to collect accounting records.
Step 4	Switch(config-acct-sel)# **list** *hex-bitmap*	Configures the list of ATM accounting MIB objects to collect.[1]

1. The MIB objects are listed in the *ATM Accounting Information MIB* publication.

The **atm accounting selection** command creates or modifies an entry in the selection table by specifying the fields of the entry.

Note A default selection entry is automatically configured during initial startup and cannot be deleted.

Some features of the ATM accounting selection table configuration include:

- An entry in the selection table points to a data collection file.
- A selection entry cannot be deleted when data collection is active.
- A selection entry can point to a nonexistent file, in which case the entry is considered inactive.
- One selection entry can apply to more than one type of VC (or example, SVC and PVC).
- If you modify a selection entry list, the new value is used the next time the data collection cycle begins, (for example, the next time the ATM accounting collection file swap occurs).

Note The following ATM accounting MIB objects are not supported:
• atmAcctngTransmittedClp0Cells (object number 16)
• atmAcctngReceivedClp0Cells (object number 18)
• atmAcctngCallingPartySubAddress (object number 31)
• atmAcctngCalledPartySubAddress (object number 32)
• atmAcctngRecordCrc16 (object number 33)

Examples

The following example shows how to change to ATM accounting selection configuration mode and add the SPVC originator connection type entry to selection entry 1:

```
Switch(config)# atm accounting selection 1
Switch(config-acct-sel)# connection-types spvc-originator
```

The following example shows how to change to ATM accounting selection configuration mode and reset the connection types for selection entry 1:

```
Switch(config)# atm accounting selection 1
Switch(config-acct-sel)# default connection-types
```

The following example shows how to change to ATM accounting selection configuration mode and configure the selection list to include all objects:

```
Switch(config)# atm accounting selection 1
Switch(config-acct-sel)# default list
```

The following example shows how to change to ATM accounting selection configuration mode and configure the selection list to include object number 20 (atmAcctngTransmitTrafficDescriptorParam1):

```
Switch(config)# atm accounting selection 1
Switch(config-acct-sel)# list 00001000
```

Displaying ATM Accounting Selection Configuration

To display the ATM accounting status, use the following EXEC command:

Command	Purpose
show atm accounting	Displays the ATM accounting selection configuration.

Example

The following example shows the ATM accounting status using the **show atm accounting** EXEC command:

```
Switch# show atm accounting
ATM Accounting Info:     AdminStatus - UP;      OperStatus : UP
Trap Threshold - 90 percent (4500000 bytes)
Interfaces:
File Entry 1: Name acctng_file1
    Descr: atm accounting data
    Min-age (seconds): 3600
    Failed_attempt : C0
    Sizes: Active 69 bytes (#records 0); Ready 73 bytes (#records 0)
➔ selection Entry -
➔     Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
➔     Selection entry 1, list - 00.00.10.00
➔     Selection entry 1, connType - F0.00
Active selection -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00

Debug output
<information deleted>
```

Configuring ATM Accounting Files

Direct the ATM accounting data being gathered from the configured selection control table to a specific ATM accounting file. To configure the ATM accounting files and change to ATM accounting file configuration mode, perform the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm accounting file acctng_file1** Switch(config-acct-file)#	Specifies the ATM accounting file and enters accounting file configuration mode.
Step 2	Switch(config-acct-file)# **collection-modes** [**on-release**] [**periodic**]	Configures when to write to the accounting file.
Step 3	Switch(config-acct-file)# **default** [**min-age**]	Resets the ATM accounting file configuration to the default.
Step 4	Switch(config-acct-file)# **description** *string*	Configures a short description for the ATM accounting file.
Step 5	Switch(config-acct-file)# **enable**	Enables ATM accounting for a specific file.
Step 6	Switch(config-acct-file)# **failed-attempts** [**none**] [**regular**] [**soft**]	Configures whether to record failed connection attempts.
Step 7	Switch(config-acct-file)# **interval** *seconds*	Configures the interval for periodic collection, in seconds.
Step 8	Switch(config-acct-file)# **min-age** *seconds*	Configures the ATM accounting file minimum age of the VC.

Note Only one ATM accounting file can be configured and that file cannot be deleted.

Examples

The following example shows how to enable ATM accounting file configuration mode for acctng_file1 and reconfigure the collection mode on release of a connection:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# collection-mode on-release
```

The following example shows how to enable ATM accounting file configuration mode for acctng_file1 and reconfigure the minimum age to the default value:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# default min-age
```

The following example shows how to enable ATM accounting file configuration mode for acctng_file1 and configure a short description to be displayed in the **show atm accounting file** display and the file header:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# description Main accounting file for engineering
```

The following example shows how to enable ATM accounting file configuration mode for acctng_file1:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# enable
```

The following example shows how to enable ATM accounting file configuration mode for acctng_file1 to collect connection data every hour:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# interval 3600
```

Displaying the ATM Accounting File Configuration

To display the ATM accounting status, use the following EXEC command:

Command	Purpose
show atm accounting	Displays the ATM accounting.

Example

The following example shows the ATM accounting file status using the **show atm accounting** EXEC command:

```
Switch# show atm accounting
ATM Accounting Info:     AdminStatus - UP;      OperStatus : UP
Trap Threshold - 90 percent (4500000 bytes)
Interfaces:
→ File Entry 1: Name acctng_file1
→     Descr: atm accounting data
→     Min-age (seconds): 3600
→     Failed_attempt : C0
→     Sizes: Active 69 bytes (#records 0); Ready 73 bytes (#records 0)
selection Entry -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00
Active selection -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00

Debug output
Sig API: Err - 0
New_Conn: OK - 0; Err - 0
Rel_Conn: OK - 0; Err - 0
New_Leg: OK - 0; Err - 0
Rel_Leg: OK - 0; Err - 0
New_Party: OK - 0; Err - 0
Rel_Party: OK - 0; Err - 0
```

Controlling ATM Accounting Data Collection

To configure the behavior of the buffers used for ATM accounting collection, use the following command in privileged EXEC mode:

Command	Purpose
atm accounting collection {**collect-now** | **swap**} *filename*	Configures the ATM accounting data collection.

Examples

The following example specifies that all VCs that meet the minimum age requirement should be collected:

```
Switch# atm accounting collection collect-now accntg_file1
```

The following example swaps the buffers used to store accounting records; the old buffer is now ready to download:

```
Switch# atm accounting collection swap acctng_file1
```

Displaying the ATM Accounting Data Collection Configuration and Status

To display the ATM accounting file configuration status, use the following EXEC command:

Command	Purpose
show atm accounting	Displays the ATM accounting status.

Example

The following example shows the ATM accounting status using the **show atm accounting files** EXEC command:

```
Switch# show atm accounting
ATM Accounting Info:     AdminStatus - UP;      OperStatus : DOWN
Trap Threshold - 90 percent (4500000 bytes)
Interfaces:
File Entry 1: Name acctng_file1
    Descr: atm accounting data
    Min-age (seconds): 3600
    Failed_attempt : C0
No file buffers initialized
selection Entry -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00
Active selection -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00
<Information deleted>
```

Configuring ATM Accounting SNMP Traps

You can configure SNMP traps to be generated when the ATM accounting file reaches a specified threshold. You can use these traps to alert you when a file is full and needs to be downloaded.

Configuring ATM Accounting Trap Generation

To configure ATM accounting SNMP traps, use the following command in global configuration mode:

Command	Purpose
atm accounting trap threshold *percent-value*	Configures the ATM accounting file threshold to generate an SNMP trap when it reaches a percentage of the maximum size.

Example

The following example shows how to configure ATM accounting SNMP traps to be sent when the file size reaches 85 percent full:

```
Switch(config)# atm accounting trap threshold 85
```

Displaying ATM Accounting Trap Threshold Configuration

To display the ATM accounting trap threshold configuration, use the following EXEC command:

Command	Purpose
show atm accounting	Displays the ATM accounting trap configuration.

Example

The following example shows the ATM accounting trap threshold configuration using the **show atm accounting** command:

```
Switch# show atm accounting
ATM Accounting Info:     AdminStatus - UP;      OperStatus : UP
➔ Trap Threshold - 90 percent (4500000 bytes)
Interfaces:
File Entry 1: Name acctng_file1
    Descr: atm accounting data
    Min-age (seconds): 3600
    Failed_attempt : C0
    Sizes: Active 69 bytes (#records 0); Ready 73 bytes (#records 0)
selection Entry -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00
Active selection -
    Selection entry 1, subtree - 1.3.6.1.4.1.9.10.18.1.1
    Selection entry 1, list - FF.FE.BF.FC
    Selection entry 1, connType - F0.00

<information deleted>
```

Configuring SNMP Server for ATM Accounting

To enable SNMP ATM accounting trap generation and specify an SNMP server, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **snmp-server enable traps atm-accounting**	Enables SNMP server ATM accounting trap generation.
Step 2	Switch(config)# **snmp-server host** *host community-string* **atm-accounting**	Configures SNMP server host IP address and community string for ATM accounting.

Example

The following example shows how to enable SNMP server ATM accounting traps and configure the SNMP server host at IP address 1.2.3.4 with community string *public* for ATM accounting:

```
Switch(config)# snmp-server enable traps atm-accounting
Switch(config)# snmp-server host 1.2.3.4 public atm-accounting
```

Displaying SNMP Server ATM Accounting Configuration

To display the SNMP server ATM accounting configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the SNMP server ATM accounting configuration.

Example

The following example shows the SNMP server ATM accounting configuration using the **more system:running-config** privileged EXEC command:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
<information deleted>
!
ip rcmd rcp-enable
ip rcmd remote-host dplatz 171.69.194.9 dplatz
ip rcmd remote-username dplatz
atm template-alias byte_wise 47.9*f8.33...
atm template-alias bit_set 47.9f9(1*0*)88ab...
atm template-alias training 47.1328...
atm accounting enable
atm accounting trap threshold 85
!
<information deleted>

no ip classless
atm route 47.0091.8100.0000.0000.0ca7.ce01... ATM3/0/0
snmp-server enable traps chassis-fail
snmp-server enable traps chassis-change
snmp-server enable traps atm-accounting
snmp-server host 1.2.3.4 public atm-accounting
!
<information deleted>
```

Using TFTP to Copy the ATM Accounting File

After the ATM accounting file is written to DRAM, you must configure TFTP to allow network requests to copy the accounting information to a host for processing. To do this, use the following command in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **access-list** *access-list-number* {**deny** | **permit**} {*source* [*source-wildcard*] | **any**}	Defines a standard IP access list using a source address and wildcard or the **any** option default source 0.0.0.0 and source mask 255.255.255.255.
Step 2	Switch(config)# **tftp-server** {**atm-acct-active:acctng_file1** | **atm-acct-ready:acctng_file1**} *ip-access-list*	Allows TFTP to copy the ATM accounting file to an IP host in response to a read request.

Example

The following example shows how to allow TFTP service to copy the ATM accounting file *acctng_file1* to the IP access list of requesting host number 1:

```
Switch(config)# access-list 1 permit 10.1.1.1
Switch(config)# tftp-server atm-acct-ready:acctng_file1 1
```

For more information about access lists, see Chapter 12, "Using Access Control."

Configuring Remote Logging of ATM Accounting Records

You can collect ATM accounting records to a remotely connected PC or UNIX workstation. You can use this method in place of, or in addition to, collecting ATM accounting records as a file into the switch's memory.

The remote logging method requires a server daemon to be running on a PC or a UNIX workstation that is reachable from the switch using IP. The server daemon listens to the TCP port specified in the switch side remote logging configuration. When the ATM accounting process on the switch sends a TCP connect request, the daemon accepts the connection. After connection has been established, the switch side ATM accounting process sends accounting records, as they are created, to the remote host. The remote host then receives the records and stores them in a local file. The collected ATM accounting records are in ASN1 format. The first record contains the format of the following records.

To configure remote logging, perform the following steps in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm accounting file acctng_file1**	Configures the ATM accounting file and changes to accounting file configuration mode.
Step 2	Switch(config)# **remote-log** [**only**] **primary-host** *hostname1 tcp-port1* [**alternate-host** *hostname2 tcp-port2*]	Specifies the main and optional backup hostname or IP address and TCP port number.

The PC or workstation configured as backup takes over collection of ATM accounting records if the primary fails. Using the keyword **only** causes only remote logging to be performed, freeing the ATM switch router's memory for other purposes.

Example

The following example shows how to configure remote logging to a PC named eagle on port 2001, with port 2002 as a backup:

```
Switch(config)# atm accounting file acctng_file1
Switch(config-acct-file)# remote-log primary-host eagle 2001 alternate-host eagle 2002
```

Displaying the Remote Logging Configuration

To display the remote logging configuration, use the following privileged EXEC command:

Command	Purpose
show atm accounting	Displays the remote logging configuration.

The following example shows the remote logging configuration using the **show atm accounting** EXEC command:

```
Switch# show atm accounting
ATM Accounting Info:     AdminStatus - UP;      OperStatus : UP
Trap Threshold - 90 percent (4500000 bytes)
Interfaces:
    AT1/0/0
    AT2/0/0
File Entry 1 -
    Name: acctng_file1
    Descr: atm accounting data
    Min-age (seconds): 0
    Failed_attempt : soft regular
    Interval (seconds) : 60
    Collect Mode : on-release periodic
    Sizes: Active 68 bytes (#records 0); Ready 74 bytes (#records 0)
    Remote Log and local storage are enabled.
    Primary Log Host: eagle, TCP listen port: 2001, OperStatus: DOWN
    Alternate Log Host: eagle, TCP listen port: 2002, OperStatus: DOWN
Selection Entry 1 -
    Subtree OID : 1.3.6.1.4.1.9.10.18.1.1
    List Bitmap : FF.FE.BF.FC
    Conn Type : svc-in svc-out pvc pvp spvc-originator spvc-target
  Active List Bitmap - FF.FE.BF.FC
```

Configuring ATM RMON

This section describes the process you use to configure ATM RMON on the ATM switch router. The following sections describe the process:

- RMON Overview, page 15-14
- Configuring Port Select Groups, page 15-15
- Configuring Interfaces into a Port Select Group, page 15-16
- Enabling ATM RMON Data Collection, page 15-17
- Configuring an RMON Event, page 15-18
- Configuring an RMON Alarm, page 15-19

RMON Overview

The ATM RMON feature allows you to monitor network traffic for reasons such as fault monitoring or capacity planning. The ATM RMON feature is an extension of an existing, well-known RMON standard and provides high-level per-host and per-conversation statistics in a standards-track MIB similar to the following RMON MIBs:

- RMON-1 MIB—RFC 1757
- RMON-2 MIB—RFC 2021 and 2074

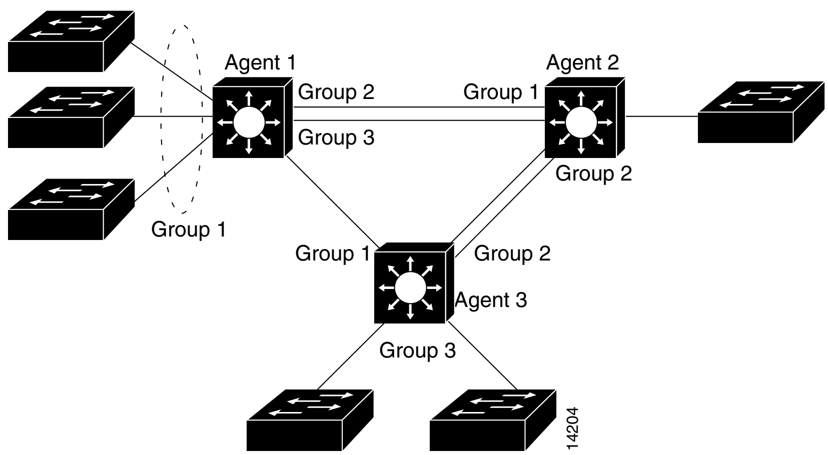
The ATM-RMON counter uses the per-VC counters already maintained in the hardware and polled by the software. The ATM RMON agent can report cell traffic statistics by monitoring connection management activity. At connection setup and release time, some ATM-RMON bookkeeping code is executed. The amount of information varies, depending on the ATM RMON configuration. The ATM-RMON bookkeeping capability significantly reduces the processing requirements for ATM-RMON, and allows collecting statistics on many or all the of ATM switch router ports at once.

The ATM-RMON agent uses the 64-bit version of each cell counter if 64-bit counter support is present in the SNMP master-agent library.

Configuring Port Select Groups

Previously, RMON allowed collection of connection information on a per-interface basis only. ATM RMON allows a group of ports to be configured as an aggregate. The port select group defines this *collection unit* used by the ATM RMON agent to gather host and matrix connection data. For example, in Figure 15-3, agent 1 has a port selection group 1 made up of ports.

Figure 15-3 ATM RMON Port Select Group Examples



An active port select group must be defined before any data collection can begin. You can use the command-line interface (CLI) and Simple Network Management Protocol (SNMP) modules to configure and access port select group structures.

To configure an RMON port selection group, use the following command in global configuration mode:

Command	Purpose
atm rmon portselgrp *number* [**descr** *string* | **host-prio** *number* | **host-scope** *number* | **matrix-prio** *number* | **matrix-scope** *number* | **maxhost** number | **maxmatrix** | **nostats** | **owner** *string*]	Configures the ATM RMON port selection group.

Example

The following example shows how to configure port selection group 7 with the a maximum host count of 500, maximum matrix count of 2000, host priority of 1, and owner name "nms 3".

```
Switch(config)# atm rmon portselgrp 7 maxhost 500 maxmatrix 2000 host-prio 1 owner "nms 3"
```

Displaying the ATM RMON Port Select Group

To display the ATM RMON port select group statistics, use the following EXEC command:

Command	Purpose
show atm rmon stats *number*	Displays the ATM RMON port select group statistics.

Example

The following example shows how to display the configuration of port selection group 3 using the **show atm rmon stats** command from EXEC mode:

```
Switch# show atm rmon stats 3
PortSelGrp: 3   Collection: Enabled     Drops: 0
  CBR/VBR: calls: 0/0  cells: 0 connTime: 0 days 00:00:00
  ABR/UBR: calls: 0/0  cells: 0 connTime: 0 days 00:00:00
```

Configuring Interfaces into a Port Select Group

Before the port selection group can begin gathering host and matrix connection information, an interface or group of interfaces must be added to the port selection group.

To configure an interface to an ATM RMON port selection group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm rmon collect** *port_sel_group*	Configures the interface to an ATM RMON port selection group.

Example

The following example shows how to configure ATM interface 0/1/3 to ATM RMON port selection group 6:

```
Switch(config)# interface atm 0/1/3
Switch(config-if)# atm rmon collect 6
```

Displaying the Interface Port Selection Group Configuration

To display the ATM RMON port configuration status, use the following EXEC command:

Command	Purpose
show atm rmon {**host** *number* | **matrix** *number* | **stats** *number* | **status**}	Displays the interface port selection group configuration.

Examples

The following example shows how to display the ATM RMON host configuration for port selection group 6 using the **show atm rmon host** command from user EXEC mode:

```
Switch# show atm rmon host 6
PortSelGrp: 6   Collection: Enabled     Drops: 0
```

The following example shows how to display the ATM RMON matrix configuration for port selection group 6 using the **show atm rmon matrix** command from user EXEC mode:

```
Switch# show atm rmon matrix 6
PortSelGrp: 6   Collection: Enabled     Drops: 0
```

The following example shows how to display the ATM RMON statistics configuration for port selection group 6 using the **show atm rmon stats** command from user EXEC mode:

```
Switch# show atm rmon stats 6
PortSelGrp: 6   Collection: Enabled     Drops: 0
  CBR/VBR: calls: 0/0  cells: 0 connTime: 0 days 00:00:00
  ABR/UBR: calls: 0/0  cells: 0 connTime: 0 days 00:00:00
```

The following example shows how to display the ATM RMON status for all port selection groups using the **show atm rmon status** command from user EXEC mode:

```
Switch# show atm rmon status
PortSelGrp: 1 Status: Enabled  Hosts:  4/no-max  Matrix:  4/no-max
        ATM0/0/0        ATM0/0/2
PortSelGrp: 2 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
        ATM0/0/3
PortSelGrp: 3 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
        ATM0/1/0        ATM0/1/1
PortSelGrp: 4 Status: Enabled  Hosts:  0/1  Matrix:  0/5
        ATM0/0/1
PortSelGrp: 5 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
        ATM0/1/2
PortSelGrp: 6 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
        ATM0/1/3
PortSelGrp: 7 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
        ATM2/0/0
PortSelGrp: 8 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max

PortSelGrp: 9 Status: Enabled  Hosts:  0/no-max  Matrix:  0/no-max
```

Enabling ATM RMON Data Collection

Use the **atm rmon enable** command to start ATM RMON data collection.

Note If you disable ATM RMON the configuration remains but becomes inactive (similar to using the **shutdown** command on an interface).

To enable ATM RMON data collection, use the following command in global configuration mode:

Command	Purpose
atm rmon enable	Enables ATM RMON.

Displaying the ATM RMON Configuration

To display the ATM RMON configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the ATM RMON configuration.

Example

The following example shows the ATM RMON configuration using the **more system:running-config** privileged EXEC command:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!

<information deleted>

ip default-gateway 172.20.53.206
no ip classless
snmp-server community public RW
snmp-server location racka-cs:2016
snmp-server contact abierman
atm rmon portselgrp 1 host-scope 3 matrix-scope 3
atm rmon portselgrp 2 host-scope 3 matrix-scope 3 descr "router port 2" owner
rubble"
atm rmon portselgrp 3 host-scope 3 matrix-scope 3 descr "test" owner "bam_bam"
atm rmon portselgrp 4 maxhost 1 maxmatrix 5 host-scope 1 descr "no active ports" owner
"wilma"
atm rmon portselgrp 5
atm rmon portselgrp 6 matrix-prio 1
atm rmon portselgrp 7 host-scope 3 matrix-scope 3 descr "CPU port" owner "pebbles"
atm rmon portselgrp 8
atm rmon portselgrp 9
atm rmon enable
!
<information deleted>
```

Configuring an RMON Event

To configure an RMON event being generated, use the following command in global configuration mode:

Command	Purpose
rmon event *number* [**log**] [**trap** *community*] [**description** *string*] [**owner** *string*]	Configures an RMON event.

Example

The following example shows how to configure a generated RMON event with an assigned name, description string, owner, and SNMP trap with community string:

```
Switch(config)# rmon event 1 description test owner nms_3 trap test
```

Displaying the Generated RMON Events

To display the generated RMON events, use the following EXEC command:

Command	Purpose
show rmon events	Displays generated RMON events.

Example

The following example shows the RMON events generated using the **show rmon events** EXEC command:

```
Switch# show rmon events
Event 1 is active, owned by nms_3
 Description is test
 Event firing causes trap to community test, last fired 00:00:00
```

Configuring an RMON Alarm

You can configure RMON alarm generation if any of the configured parameters are met.

Note Refer to the *Configuration Fundamentals Configuration Guide* for general SNMP RMON configuration information.

To configure RMON alarms, use the following command in global configuration mode:

Command	Purpose
rmon alarm *number variable interval* {**delta** | **absolute**} **rising-threshold** *value* [*event-number*] **falling-threshold** *value* [*event-number*] [**owner** *string*]	Configures the ATM RMON alarm.

Example

The following example shows how to configure RMON alarm number 1 to generate an alarm under the following conditions:

- If the MIB atmHostHCCells exceed 500
- If each sample, in absolute mode, shows:
  - Rising threshold exceeding 10,000
  - Falling threshold falling below 1000
- The RMON alarm number 1 sends the alarm to the owner “nms 3”

```
Switch(config)# rmon alarm 1 atmHostInHCCells 500 absolute rising-threshold 10000
falling-threshold 1000 owner “nms 3”
```

Displaying the Generated RMON Alarms

To display the RMON alarm event, use the following EXEC command:

Command	Purpose
show rmon alarms events	Displays RMON alarms.

Example

The following example shows the RMON alarms and events using the **show rmon alarms events** EXEC command:

```
Switch# show rmon alarms events
Event 1 is active, owned by nms 3
 Description is test
 Event firing causes trap to community test, last fired 00:00:00
Alarm table is empty
```

Configuring SNMP

This section describes the process you use to configure specific ATM interface features of SNMP on the ATM switch router. The following sections describe the process:

SNMP Overview

The Simple Network Management Protocol (SNMP) system consists of the following three parts:

- An SNMP manager
- An SNMP agent
- A MIB

SNMP is an application-layer protocol that provides a message format for communication between SNMP managers and agents.

The SNMP manager can be part of a Network Management System (NMS) such as CiscoWorks. The agent and MIB reside on the ATM switch router. To configure SNMP on the ATM switch router, you define the relationship between the manager and the agent.

The SNMP agent contains MIB variables whose values the SNMP manager can request or change. A manager can get a value from an agent or store a value into that agent. The agent gathers data from the MIB, the repository for information about device parameters and network data. The agent can also respond to a manager’s requests to get or set data.

An agent can send unsolicited traps to the manager. Traps are messages alerting the SNMP manager to a condition on the network. Traps can indicate improper user authentication, restarts, link status (up or down), closing of a TCP connection, loss of connection to a neighbor router, ATM switch router, or other significant events.

The MIB is a virtual information storage area for network management information, which consists of collections of managed objects.

For a detailed description of SNMP and SNMP configuration see the following IOS documents:

- Configuring Simple Network Management Protocol (SNMP)
- SNMP Commands

Configuring SNMP-Server Hosts

To configure the recipient of an SNMP trap operation, use the following command in global configuration mode:

Command	Purpose
Switch(config)# **snmp-server host** *host* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*]	Configures the recipient of an SNMP trap operation.

Note The ATM switch router has additional SNMP configuration features and parameters than those described in the base IOS documentation. See the *ATM Switch Router Command Reference* document for SNMP configuration commands specifically for the ATM switch router.

Configuring SNMP Traps

To configure the ATM switch router to send SNMP traps, use the following commands in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **snmp-server engineID remote** *remote-ip-addr remote-engineID*	Specifies the engine ID for the remote host.
Step 2	Switch(config)# **snmp-server user** *username groupname* **remote** *remote-ip-addr* **v3**	Configures an SNMP user to be associated with the above host. **Note** You cannot configure a remote user for an address without configuring the engine ID for that remote host first. This is a restriction imposed in the design of these commands; if you try to configure the user before the host, you will receive a warning message and the command will not be executed.
Step 3	Switch(config)# **snmp-server group** [*groupname* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**}}] [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*]	Configures a group on a remote device.

	Command	Purpose
Step 4	Switch(config)# **snmp-server host** *host-addr* **traps** [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] **groupname** [*notification-type*]	Specifies the recipient of the trap message. For details on the notification types available, see the description of this command in the *ATM Switch Router Command Reference*.
Step 5	Switch(config)# **snmp-server enable traps** [*notification-type*] [*notification-option*]	Enables the sending of traps or informs, and specifies the type of notifications to be sent. For details on the notification types available, see the description of this command in the *ATM Switch Router Command Reference*.
Step 6	Switch(config)# **snmp-server manager**	Enables the SNMP manager.

The **snmp-server host** command specifies which hosts will receive traps. The **snmp-server enable traps** command globally enables the trap production mechanism for the specified traps.

In order for a host to receive a trap, an **snmp-server host** command must be configured specifying the intended host, and the trap must be enabled globally through the **snmp-server enable traps** command.

Note The ATM switch router has additional SNMP configuration features and parameters than those described in the base IOS documentation. See the *ATM Switch Router Command Reference* document for SNMP configuration commands specifically for the ATM switch router.

Configuring Interface Index Persistence

The interface index persistence feature allows interfaces to be identified with unique values that remain constant even when a device is rebooted. These interface identification values apply to network monitoring and management using SNMP.

The interface index (ifIndex) value is one of the most commonly used identifiers in SNMP-based network management applications. IfIndex is a unique identifying number associated with a physical or logical interface; for most software, the ifIndex is the "name" of the interface.

Although no requirement exists in the relevant RFCs that the correspondence between particular ifIndex values and their interfaces be maintained across reboots, applications such as device inventory, billing, and fault detection increasingly depend on the maintenance of this correspondence.

It is currently possible to poll the switch router at regular intervals to correlate the interfaces to the ifIndex, but it is not practical to poll this interface constantly. If this data is not correlated constantly, however, the data may become invalid because of a reboot or the insertion of a new module into the switch router between polls. Therefore, ifIndex persistence is the only way to guarantee data integrity.

IfIndex persistence also means that the mapping between the ifDescr object values and the ifIndex object values (generated from the IF-MIB) will be retained across reboots.

For detailed overview and configuration information about this feature see the chapter, "**Interface Index Persistence**" of the IOS documentation.

SNMP Examples

The following example permits any SNMP to access all objects with read-only permission using the community string named "public." The ATM switch router will also send ATM interface traps to the hosts "192.180.1.111" and "192.180.1.33" using SNMPv1 and to the host "192.180.1.27" using SNMPv2C. The community string "public" is sent with the traps.

```
Switch(config)# snmp-server community public
Switch(config)# snmp-server enable traps atm if-event
Switch(config)# snmp-server host 192.180.1.27 version 2c public
Switch(config)# snmp-server host 192.180.1.111 version 1 public
Switch(config)# snmp-server host 192.180.1.33 public
```

The following example sends the SNMP traps to the host specified by the name myhost.cisco.com. The community string is defined as "comaccess".

```
Switch(config)# snmp-server enable traps
Switch(config)# snmp-server host myhost.cisco.com comaccess snmp
```

The following example sends the ATM interface event SNMP traps (using the **atm if-event** keywords) and the "admin" username to address "172.30.2.160":

```
Switch(config)# snmp-server host 172.30.2.160 traps admin atm if-event
```

Displaying the SNMP Configuration

To display the SNMP configuration, use the following privileged EXEC command:

Command	Purpose
show snmp	Used to show the status of communications between the SNMP agent and SNMP manager.

Example

The following example shows the SNMP configuration using the **show snmp** privileged EXEC command:

```
Switch# show snmp
497 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    50 Number of requested variables
    249 Number of altered variables
    30 Get-request PDUs
    162 Get-next PDUs
    249 Set-request PDUs
441 SNMP packets output
    0 Too big errors (Maximum packet size 1500)
    162 No such name errors
    0 Bad values errors
    0 General errors
    441 Response PDUs
    0 Trap PDUs
SNMP global trap: enabled

SNMP logging: enabled
    Logging to 172.20.52.3.162, 0/10, 0 sent, 0 dropped.
```

The following example shows the SNMP group configuration using the **show snmp group** privileged EXEC command:

```
Switch# show snmp group
groupname: ILMI                         security model:v1
readview :*ilmi                         writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: ILMI                         security model:v2c
readview :*ilmi                         writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: comaccess                    security model:v1
readview :v1default                     writeview: <no writeview specified>
notifyview: *tv.FFFFFFFF.FFFFFFFF
row status: active

groupname: comaccess                    security model:v2c
readview :v1default                     writeview: <no writeview specified>
notifyview: <no notifyview specified>
row status: active

Switch#
```

CHAPTER 16

Configuring Tag Switching and MPLS

This chapter describes tag switching, a high-performance packet-forwarding technology that assigns tags to mulitprotocol frames for transport across packet- or cell-based networks.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For an overview of tag switching, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Tag Switching Overview

In conventional Layer 3 forwarding, as a packet traverses the network, each router extracts forwarding information from the Layer 3 header. Header analysis is repeated at each router (hop) through which the packet passes.

In a tag switching network, the Layer 3 header is analyzed just once. It is then mapped into a short fixed-length tag. At each hop, the forwarding decision is made by looking only at the value of the tag. There is no need to reanalyze the Layer 3 header. Because the tag is a fixed-length, unstructured value, lookup is fast and simple.

For an overview of how tag switching works and its benefits, refer to the *Guide to ATM Technology*.

Hardware and Software Requirements and Restrictions (Catalyst 8540 MSR)

The Catalyst 8540 MSR hardware requirements for tag switching include the following:

- The ATM switch router (used as a tag switch)
- A tag edged router such as a Cisco 7000 Route Switch Processor (RSP) with an Optical Carrier 3 (OC-3) ATM interface processor (AIP) installed

Tag switching has the following software restrictions:

- Open Shortest Path First (OSPF) is the only routing protocol currently supported.
- IP is the only network layer protocol supported.
- Hierarchical VP tunnels cannot co-exist on a physical interface with tag switching.

Hardware and Software Requirements and Restrictions (Catalyst 8510 MSR and LightStream 1010)

The Catalyst 8510 MSR and LightStream 1010 ATM switch router hardware requirements for tag switching include the following:

- The ATM switch router (used as a tag switch).
- A switch processor feature card installed on the route processor, if you want to enable VC merge (multipoint-to-point connection). Note that FC-PFQ requires 64 MB of DRAM.
- A tag edged router such as a Cisco 7000 RSP with an OC-3 AIP installed.

Tag switching has the following software restrictions:

- Open Shortest Path First (OSPF) is the only routing protocol currently supported.
- IP is the only network layer protocol supported.
- Hierarchical VP tunnels cannot co-exist on a physical interface with tag switching.

Configuring Tag Switching

This section describes how to configure tag switching on ATM switch routers, and includes the following procedures:

- Configuring a Loopback Interface, page 16-3
- Enabling Tag Switching on the ATM Interface, page 16-4
- Configuring OSPF, page 16-5

Configuring a Loopback Interface

You should configure a loopback interface on every ATM switch router configured for tag switching. The loopback interface, a virtual interface, is always active. The IP address of the loopback interface is used as the Tag Distribution Protocol (TDP) identifier for the ATM switch router. If a loopback interface does not exist, the TDP identifier is the highest IP address configured on the ATM switch router. If that IP address is administratively shut down, all TDP sessions through the ATM switch router restart. Therefore, we recommend that you configure a loopback interface.

To configure the loopback interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface loopback** *number* Switch(config-if)#	Enters interface configuration mode and assigns a number to the loopback interface.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Assigns an IP address and subnet mask to the loopback interface. **Note** We recommend a 32-bit subnet mask (255.255.255.255) for the loopback interface. If you do not use a 32-bit subnet mask, two TVCs[1] terminate for the same address—one for a 32-bit subnet mask and the other for the mask you entered. Entering a 32-bit subnet mask reduces the number of TVCs to one.

1. TVCs = tag virtual channels.

Example

In the following example, loopback interface 0 is created with an IP address of 1.0.1.11 and a subnet mask of 255.255.255.255:

```
Switch(config)# interface loopback 0
Switch(config-if)# ip address 1.0.1.11 255.255.255.255
Switch(config-if)# exit
```

Displaying Loopback Interface Configuration

The following example shows the loopback 0 configuration using the **show interfaces** privileged EXEC command:

```
Switch# show interfaces loopback 0
Loopback0 is up, line protocol is up
  Hardware is Loopback
```

```
Internet address is 1.0.1.11/24
MTU 1500 bytes, BW 8000000 Kbit, DLY 5000 usec, rely 255/255, load 1/255
Encapsulation LOOPBACK, loopback not set, keepalive set (10 sec)
Last input 00:00:03, output never, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/0, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   0 packets input, 0 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
   73 packets output, 0 bytes, 0 underruns
   0 output errors, 0 collisions, 0 interface resets
   0 output buffer failures, 0 output buffers swapped out
```

Enabling Tag Switching on the ATM Interface

Note Configure all parallel interfaces between ATM switch routers for either IP unnumbered or with a specific IP address. Unnumbering some parallel interfaces and assigning specific IP addresses to others might cause TDP sessions to restart on some parallel interfaces when another parallel interface is shut down. Therefore, we highly recommend that you unnumber all parallel interfaces to loopback.

To enable tag switching on the ATM interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Enters interface configuration mode on the specified ATM interface.
Step 2	Switch(config-if)# **ip unnumbered** *type number* or Switch(config-if)# **ip address** *ip-address mask*	Enables IP unnumbered on the ATM interface and assigns the unnumbered interface to an interface that has an IP address. We recommend enabling IP unnumbered because it allows you to conserve IP addresses and it reduces the number of TVCs terminating on the switch. or Assigns an IP address and subnet mask to the ATM interface.
Step 3	Switch(config-if)# **tag-switching ip**	Enables tag switching of IPv4 packets.

Examples

In the following example, ATM interface 1/0/1 is configured for IP unnumbered to loopback interface 0:

```
Switch(config-if)# interface atm 1/0/1
Switch(config-if)# ip unnumbered loopback 0
Switch(config-if)# tag-switching ip
Switch(config-if)# exit
```

In the following example, ATM interface 0/0/3 is configured with a specific IP address and subnet mask (1.3.11.3 255.255.0.0):

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# ip address 1.3.11.3 255.255.0.0
Switch(config-if)# tag-switching ip
Switch(config-if)# exit
```

Displaying the ATM Interface Configuration

To display the ATM interface configuration, use the following EXEC command:

Command	Purpose
show tag-switching interfaces	Displays the tag switching configuration on the ATM interface.

The following example shows that tag switching is configured on ATM interfaces 0/0/3 and 1/0/1:

```
Switch# show tag-switching interfaces
Interface              IP    Tunnel   Operational
ATM0/0/3               Yes   No       Yes          (ATM tagging)
ATM1/0/1               Yes   No       Yes          (ATM tagging)
```

Configuring OSPF

Enable OSPF on the ATM switch router so that it can create routing tables, which identify routes through the network. Then add the addresses and associated routing areas to the OSPF process so that it can propagate the addresses to other ATM switch routers:

	Command	Purpose
Step 1	Switch(config)# **router ospf** *process_number* Switch(config-router)#	Enables OSPF and assigns it a process number. The process number can be any positive integer.
Step 2	Switch(config-router)# **network** *address wildcard-mask* **area** *area-id*	Defines the network prefix, a wildcard subnet mask, and the associated area number on which to run OSPF. An area number is an identification number for an OSPF address range. Repeat this command for each additional area you want to add to the OSPF process. **Caution** Ethernet0 is used for system management only. Do not add this interface to the routing protocol process.

Note Since the 12.0(1a)W5(5b) release of the system software, addressing the interface on the route processor (CPU) has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. Old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

Example

The following is an example of OSPF enabled and assigned process number 10000. All addresses are in area 0:

Note An IP address of 1.1.1.1 with a subnet mask of 255.255.255.0 is entered as an IP network prefix of 1.1.1.0 with a subnet mask of 0.0.0.255. Likewise, an IP address of 1.2.1.1 with a subnet mask of 255.255.255.0 is entered as an IP network prefix of 1.2.1.0 with a subnet mask of 0.0.0.255.

```
Switch(config)# router ospf 10000
Switch(config-router)# network 1.1.1.0 0.0.0.255 area 0
Switch(config-router)# network 1.2.1.0 0.0.0.255 area 0
Switch(config-router)# network 1.3.0.0 0.0.255.255 area 0
Switch(config-router)# network 200.2.2.0 0.0.0.255 area 0
Switch(config-router)# network 1.0.1.0 0.0.0.255 area 0
Switch(config-router)# network 1.18.0.0 0.0.255.255 area 0
```

Displaying the OSPF Configuration

To display the OSPF configuration, use the following privileged EXEC command:

Command	Purpose
show ip ospf	Displays the OSPF configuration.

The following example shows the OSPF configuration using the **show ip ospf** privileged EXEC command:

```
Switch# show ip ospf
 Routing Process "ospf 10000" with ID 1.0.1.11
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
    Area BACKBONE(0) (Inactive)
        Number of interfaces in this area is 4
        Area has no authentication
        SPF algorithm executed 2 times
        Area ranges are
        Link State Update Interval is 00:30:00 and due in 00:14:42
        Link State Age Interval is 00:20:00 and due in 00:14:10
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
```

Configuring a VPI Range (Optional)

Although not necessary for most configurations, you might need to change the default tag virtual path identifier (VPI) range on the switch if:

- It is an administrative policy to use a VPI value other than 1, the default VPI.
- There are a large number of tag virtual channels (TVCs) on an interface.

Note You cannot enter a VPI range on a VP tunnel. On VP tunnels, the VPI is the permanent virtual path (PVP) number of the tunnel.

To change the default tag VPI range, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Enters interface configuration mode on the specified ATM interface.
Step 2	Switch(config-if)# **tag-switching atm vpi** *vpi* [**–** *vpi*]	Enters the VPI range. **Note** If the TDP neighbor is a router, the VPI range can be no larger than two. For example, from 5 to 6 (a range of two), not 5 to 7 (a range of three). If the TDP neighbor is a switch, the maximum VPI range is 0 to 255.

Examples

The following example shows how to select a VPI range from 5 to 6 (a range of two), an acceptable range if the TDP neighbor is a router:

```
Switch(config)# interface atm 3/0/1
Switch(config-if)# tag-switching ip
Switch(config-if)# tag-switching atm vpi 5 - 6
```

The following example shows how to select a VPI range from 5 to 7 (a range of three), an acceptable range if the TDP neighbor is a switch:

```
Switch(config)# interface atm 3/0/1
Switch(config-if)# tag-switching ip
Switch(config-if)# tag-switching atm vpi 5 - 7
```

Note Although the example shows a VPI range of three, you are not limited to a range of three if the TDP neighbor is a switch. The maximum VPI range is 0 to 255 if the TDP neighbor is a switch.

Displaying the Tag Switching VPI Range

To display the tag switching VPI range, use the following EXEC command:

Command	Purpose
show tag-switching interfaces detail	Displays the tag switching VPI range on an interface.

Example

The following example shows the tag switching VPI range on ATM interface 1/0/1:

```
Switch# show tag-switching interfaces detail
Interface ATM0/0/3:
        IP tagging enabled
        TSP Tunnel tagging not enabled
        Tagging operational
        MTU = 4470
        ATM tagging: Tag VPI = 1, Control VC = 0/32
Interface ATM1/0/1:
```

```
        IP tagging enabled
        TSP Tunnel tagging not enabled
        Tagging operational
        MTU = 4470
        ATM tagging: Tag VPI range = 5 - 6, Control VC = 6/32
<information deleted>
```

Configuring TDP Control Channels (Optional)

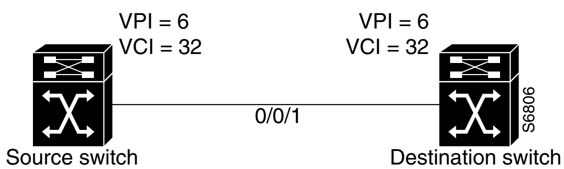
Although not necessary for most configurations, you can change the default Tag Distribution Protocol (TDP) control channel VPI and virtual channel identifier (VCI) if you want to use a nondefault value. The default TDP control channel is on VPI 0 and VCI 32. TDP control channels exchange TDP HELLOs and Protocol Information Elements (PIEs) to establish two-way TDP sessions. TVCs are created by the exchange of PIEs through TDP control channels.

To change the TDP control channel, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Enters interface configuration mode on the specified ATM interface.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Assigns an IP address and subnet mask to the ATM interface.
Step 3	Switch(config-if)# **tag-switching ip**	Enables tag switching of IPv4 packets.
Step 4	Switch(config-if)# **tag-switching atm control-vc** *vpi vci*	Changes the TDP control channel.

Figure 16-1 shows an example TDP control channel configuration between a source switch and destination switch on ATM interface 0/0/1. Note that the VPI and VCI values match on the source switch and destination switch.

Figure 16-1 Configuring TDP Control Channels



Examples

In the following example, a TDP control channel is configured on the source switch:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# ip address 1.2.0.11 255.255.255.0
Switch(config-if)# tag-switching ip
Switch(config-if)# tag-switching atm control-vc 6 32
Switch(config-if)# exit
```

In the following example, a TDP control channel is configured on the destination switch:

```
Switch(config)# interface atm 0/0/1
```

```
Switch(config-if)# ip address 1.2.0.12 255.255.255.0
Switch(config-if)# tag-switching ip
Switch(config-if)# tag-switching atm control-vc 6 32
Switch(config-if)# exit
```

If you are having trouble establishing a TDP session, verify that the VPI and VCI values match on the TDP control channels of the source switch and destination switch.

Displaying the TDP Control Channels

To display the TDP control channel configuration, use the following EXEC command:

Command	Purpose
show tag-switching interfaces detail	Displays the TDP control channel configuration on an interface.

The following example shows the TDP control channel configuration on interface ATM 0/0/3:

```
Switch# show tag-switching interfaces detail
Interface ATM0/0/3:
        IP tagging enabled
        TSP Tunnel tagging not enabled
        Tagging operational
        MTU = 4470
➔       ATM tagging: Tag VPI = 1, Control VC = 0/32
<information deleted>
```

Configuring Tag Switching on VP Tunnels

If you want to configure tag switching on virtual path (VP) tunnels, perform the following steps, beginning in global configuration mode:

Note This procedure is optional.

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Enters interface configuration mode on the specified ATM interface.
Step 2	Switch(config-if)# **atm pvp** *vpi*	Creates a PVP. When configuring PVP connections, configure the lowest VPI numbers first.
Step 3	Switch(config-if)# **exit** Switch(config)#	Returns to global configuration mode.
Step 4	Switch(config)# **interface atm** *card*/*subcard*/*port*.*subinterface#* Switch(config-subif)#	Enters subinterface configuration mode.

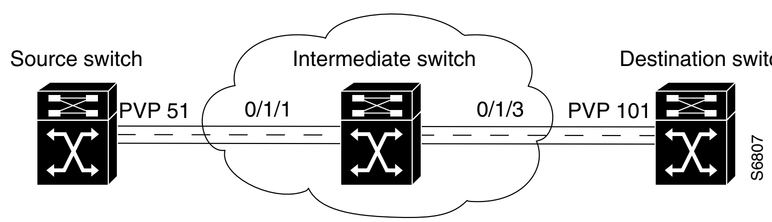
	Command	Purpose
Step 5	Switch(config-subif)# **ip unnumbered** *type number*	Enables IP unnumbered on the ATM interface and assigns the unnumbered interface to an interface that has an IP address. We recommend enabling IP unnumbered because it allows you to conserve IP addresses and reduces the number of TVCs terminating on the switch.
	or	or
	Switch(config-subif)# **ip address** *ip-address mask*	Assigns an IP address and subnet mask to the ATM interface.
Step 6	Switch(config-subif)# **tag-switching ip**	Enables tag switching of IPv4 packets.

Because a VP tunnel runs between switches, you must also configure a VP tunnel on the connecting ATM interface on the destination switch. The examples that follow show how to configure VP tunnels between switches.

Note The intermediate switch configuration follows in the next section, "Connecting the VP Tunnels."

Figure 16-2 shows an example VP tunnel between a source switch and destination switch.

Figure 16-2 Configuring VP Tunnels



Examples

In the following example, ATM interface 0/1/1 on the source switch has no IP address and PVP 51 is configured for IP unnumbered to loopback interface 0:

```
Switch(config-if)# interface atm 0/1/1
Switch(config-if)# atm pvp 51
Switch(config-if)# exit
Switch(config-if)# interface atm 0/1/1.51
Switch(config-subif)# ip unnumbered loopback 0
Switch(config-subif)# tag-switching ip
Switch(config-subif)# exit
```

In the following example, ATM interface 0/1/3 on the destination switch has no IP address and PVP 101 is configured for IP unnumbered to loopback interface 0:

```
Switch(config)# interface atm 0/1/3
Switch(config-if)# atm pvp 101
Switch(config-if)# exit
Switch(config)# interface atm 0/1/3.101
Switch(config-subif)# ip unnumbered loopback 0
Switch(config-subif)# tag-switching ip
Switch(config-subif)# exit
```

To connect the source and destination switch VP tunnels, proceed to the next section, "Connecting the VP Tunnels."

Displaying the VP Tunnel Configuration

To display the VP tunnel configuration, use the following EXEC command:

Command	Purpose
show atm vp	Displays the VP tunnel configuration on an interface.

The following example shows PVP 51 configured on ATM interface 0/1/1:

```
Switch# show atm vp
Interface     VPI     Type  X-Interface     X-VPI     Status
ATM0/1/1      51       PVP     TUNNEL
```

Connecting the VP Tunnels

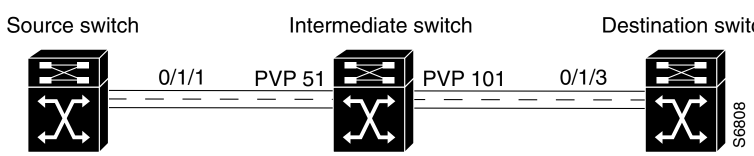
To complete the VP tunnel, you must configure the ATM ports on the intermediate switch to designate where to send packets coming from the source switch and going to the destination switch.

To connect the permanent virtual path (PVP), perform the following steps, beginning in interface configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Enters interface configuration mode on the specified ATM interface.
Step 2	Switch(config-if)# **atm pvp** *vpi* **interface atm** *card/subcard/port vpi-B*	Connects the PVP from the source switch to the destination switch.

Figure 16-3 shows an example configuration on an intermediate switch.

Figure 16-3 Connecting the VP Tunnels



Example

In the following example, PVP 51 on ATM interface 0/1/1 is connected to PVP 101 on ATM interface 0/1/3:

```
Switch(config)# interface atm 0/1/1
Switch(config-if)# atm pvp 51 interface atm 0/1/3 101
Switch(config-if)# exit
```

Displaying the VP Tunnel Configuration

The following example shows PVP 51 on ATM interface 0/1/1 connected to PVP 101 on ATM interface 0/1/3:

```
Switch# show atm vp
Interface    VPI    Type  X-Interface     X-VPI     Status
ATM0/1/1     51      PVP     ATM0/1/3     101       DOWN
ATM0/1/3     101     PVP     ATM0/1/1     51        DOWN
```

Configuring VC Merge

VC merge allows the switch to aggregate multiple incoming flows with the same destination address into a single outgoing flow. Where VC merge occurs, several incoming tags are mapped to one single outgoing tag. Cells from different VCIs going to the same destination are transmitted to the same outgoing VC using multipoint-to-point connections. This sharing of tags reduces the total number of virtual circuits required for tag switching. Without VC merge, each source-destination prefix pair consumes one tag VC on each interface along the path. VC merge reduces the tag space shortage by sharing tags for different flows with the same destination.

Note VC merge support requires FC-PFQ on the route processor. If you do not have FC-PFQ, and you try to enable VC merge, the TVCs remain point-to-point. (Catalyst 8510 MSR and LightStream 1010)

VC merge is enabled by default. To disable VC merge, enter the following command in global configuration mode:

Command	Purpose
no tag-switching atm vc-merge	Disables VC merge.

Displaying the VC Merge Configuration

To display the VC merge configuration, use the following EXEC command:

Command	Purpose
show tag-switching atm-tdp capability	Displays the TDP control channel configuration on an interface.

The following example shows that VC merge configuration is enabled on ATM interface 0/1/0:

```
Switch# show tag-switching atm-tdp capability

                Control     VPI           VCI           Alloc   VC Merge
ATM0/1/0        VP    VC    Range         Range         Scheme  IN   OUT
  Negotiated    0     32    [7 - 8]       [33 - 1023]   UNIDIR  -    -
  Local         -     -     [7 - 8]       [33 - 16383]  UNIDIR  Yes  Yes
  Peer          -     -     [7 - 8]       [33 - 1023]   UNIDIR  -    -
```

Configuring Tag Switching CoS

Quality of service (QoS) allows ATM to meet the transmission *quality* and *service* availability of many different types of data. The need for delay-sensitive data, such as voice, can be given a higher priority than data that is not delay-sensitive, such as e-mail. The following service categories were created for ATM Forum VCs to meet the transmission needs of various types of data: VBR-RT, VBR-NRT, ABR, and UBR. See Chapter 9, "Configuring Resource Management," for more information about the standard ATM Forum implementation of QoS. This section describes tag switching class of service (CoS).

Up to eight QoS classes (0 to 7) can be allocated to each physical interface port. Each port has an independent logical rate scheduler (RS) and a weighted round-robin (WRR) scheduler. The RS guarantees minimum bandwidth and has first priority on supplying an eligible cell for transmission. Second priority is given to the service classes, which have been assigned relative weights that are based on the ratio of the total leftover bandwidth. The service class relative weights are configurable so you can change the priority of the default values. The VCs within a service class also have relative weights. The service classes and VCs within a service class are scheduled by their relative weights.

With tag switching CoS, tag switching can dynamically set up to four tag virtual channels (TVCs) with different service categories between a source and destination. TVCs do not share the same QoS classes reserved for ATM Forum VCs (VBR-RT, VBR-NRT, ABR, and UBR). The following four new service classes were created for TVCs: TBR_1 (WRR_1), TBR_2 (WRR_2), TBR_3 (WRR_3), and TBR_4 (WRR_4). These new service classes are called Tag Bit Rate (TBR) classes. TVCs and ATM Forum VCs can only coexist on the same physical interface, but they operate in ships in the night (SIN) mode and are unaware of each other.

TBR classes support only best-effort VCs (similar to the ATM Forum service category UBR); therefore, there is no bandwidth guarantee from the RS, which is not used for TVCs. All of the TVCs fall into one of the four TBR classes, each carrying a different default relative weight. The default values of the relative weights for the four TBR classes are configurable, so you can change the priority of the default values.

Table 16-1and Table 16-2 list the TBR classes and ATM Forum class mappings into the service classes for physical ports.

Table 16-1 Service Class to Weight Mapping for Physical Ports

TBR Class	Service Class	Relative Weight
TBR_1 (WRR_1)	1	1
TBR_2 (WRR_2)	6	2
TBR_3 (WRR_3)	7	3
TBR_4 (WRR_4)	8	4

Table 16-2 ATM Forum Class Mapping for Physical Ports

ATM Forum Service Category	Service Class	Relative Weight
CBR[1]	2	8
VBR-RT	2	8
VBR-NRT	3	1

Table 16-2 ATM Forum Class Mapping for Physical Ports

ATM Forum Service Category	Service Class	Relative Weight
ABR	4	1
UBR	5	1

1. Even though the CBR service category is mapped to service class 2, all of the CBR VCs are rate scheduled only, and therefore they are not WRR scheduled.

When tag switching is enabled on a hierarchical VP tunnel, the tunnel can only be used for tag switching. Because hierarchical VP tunnels support only four service classes, both TVCs and ATM Forum VCs map to the same service classes. Therefore, both ATM Forum VCs and TVCs cannot coexist in a hierarchical VP tunnel. The relative weights assigned to the service classes depend on which is active (either tag switching or ATM Forum). The class weights change whenever a hierarchical VP tunnel is toggled between ATM Forum and tag switching. By default, a hierarchical VP tunnel comes up as an ATM Forum port.

Table 16-3 and Table 16-4 list the TBR classes and ATM Forum service category mappings for hierarchical VP tunnels.

Table 16-3 Service Class to Weight Mapping for Hierarchical VP Tunnels

TBR Class	Service Class	Relative Weight
TBR_1 (WRR_1)	1	1
TBR_2 (WRR_2)	2	2
TBR_3 (WRR_3)	3	3
TBR_4 (WRR_4)	4	4

Table 16-4 ATM Forum Service Category Mapping for Hierarchical VP Tunnels

ATM Forum Service Category	Service Class	Relative Weight
VBR-RT	1	8
VBR-NRT	2	1
ABR	3	1
UBR	4	1

Configuring the Service Class and Relative Weight

Each service class is assigned a relative weight. These weights are configurable and range from 1 to 15.

To configure the service class and relative weight on a specific interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm service-class** {**1** | **6** | **7** | **8**} **wrr-weight** *weight* or Switch(config-if)# **atm service-class** {**1** | **2** | **3** | **4**} **wrr-weight** *weight*	Enters the service class and relative weight for a physical interface. or Enters the service class and relative weight for a hierarchical interface.

Example

In the following example, ATM interface 0/0/3 is configured with service class 1 and a WRR weight of 3:

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# atm service-class 1 wrr-weight 3
```

Displaying the TVC Configuration

To display the TVC configuration, perform the following task in EXEC mode:

Command	Purpose
show atm vc interface atm *card***/***subcard***/***port* [*vpi vci*]	Displays the ATM layer connection information about the virtual connection.

The following example shows the service category of the TVC:

```
Switch# show atm vc interface atm 0/0/3 1 35
Interface: ATM0/0/3, Type: oc3suni
VPI = 1  VCI = 35
Status: UP
Time-since-last-status-change: 1d00h
Connection-type: TVC(I)
Cast-type: multipoint-to-point-input
Packet-discard-option: enabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0/1/3.10, Type: oc3suni
Cross-connect-VPI = 10
Cross-connect-VCI = 34
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Threshold Group: 7, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx pkts:0, Rx pkt drops:0
```

```
    Rx connection-traffic-table-index: 63998
➔   Rx service-category: WRR_1 (WRR Bit Rate)
    Rx pcr-clp01: none
    Rx scr-clp01: none
    Rx mcr-clp01: none
    Rx      cdvt: 1616833580 (from default for interface)
    Rx       mbs: none
    Tx connection-traffic-table-index: 63998
➔   Tx service-category: WRR_1 (WRR Bit Rate)
    Tx pcr-clp01: none
    Tx scr-clp01: none
    Tx mcr-clp01: none
    Tx      cdvt: none
    Tx       mbs: none
```

Threshold Group for TBR Classes

A threshold group utilizes the memory efficiently among VCs of a particular traffic type. Each threshold group is programmed with a dynamic memory allocation profile that maps into the needs of the connections of a particular service class. There are 16 threshold groups (0 to 15) available on the ATM switch router. Each threshold group has a set of eight regions, and each region has a set of thresholds. When these thresholds are exceeded, cells are dropped to maintain the integrity of the shared memory resource.

Each ATM Forum service category is mapped into a distinct threshold group. All the connections in a particular service category map into one threshold group. Similarly, all the Tag Bit Rate (TBR) classes have best effort traffic and the service differentiation comes mainly by giving different weights. Each of the TBR classes map into four different threshold groups whose parameters are the same as the unspecified bit rate (UBR) threshold group.

Table 16-5 shows the threshold group parameters mapped to the connections in all of the TBR classes for the Catalyst 8540 MSR.

Table 16-5 Threshold Group Parameters for TVCs (Catalyst 8540 MSR)

Group	Maximum Cells	Maximum Queue Limit	Minimum Queue Limit	Mark Threshold	Discard Threshold	Use
7	131,071	511	31	25%	87%	TBR_1
8	131,071	511	31	25%	87%	TBR_2
9	131,071	511	31	25%	87%	TBR_3
10	131,071	511	31	25%	87%	TBR_3

Table 16-6 shows the threshold group parameters mapped to the connections in all of the TBR classes for the Catalyst 8510 MSR and LightStream 1010 ATM switch routers.

Table 16-6 Threshold Group Parameters for TVCs (Catalyst 8510 MSR and LightStream 1010)

Group	Maximum Cells	Maximum Queue Limit	Minimum Queue Limit	Mark Threshold	Discard Threshold	Use
7	65,535	511	31	25%	87%	TBR_1
8	65,535	511	31	25%	87%	TBR_2
9	65,535	511	31	25%	87%	TBR_3
10	65,535	511	31	25%	87%	TBR_3

Each threshold group is divided into eight regions. Each region has a set of thresholds that are calculated from the corresponding threshold group parameters given in Table 16-5. The threshold group might be in any one of the regions depending on the fill level (cell occupancy) of that group. And that region is used to derive the set of thresholds which apply to all the connections in that group.

Table 16-7 gives the eight thresholds for threshold groups 6, 7, 8, and 9.

Table 16-7 Region Thresholds for Threshold Groups

Region	Lower Limit	Upper Limit	Queue Limit	Marking Threshold	Discard Threshold
0	0	8191	511	127	447
1	8128	16,383	255	63	223
2	16,320	24,575	127	31	111
3	24,512	32,767	63	15	63
4	32,704	40,959	31	15	31
5	40,896	49,151	31	15	31
6	49,088	57,343	31	15	31
7	57,280	65,535	31	15	31

For more information about threshold groups and configuration parameters, see Chapter 9, "Configuring Resource Management," and the *Guide to ATM Technology*.

CTT Row

A row in the connection traffic table (CTT) is created for each unique combination of traffic parameters. When a TVC is set up in response to a request by tag switching, a CTT row is obtained from the resource manager by passing the traffic parameters that include the service category (TBR_*x* [WRR_*x*], where *x* is 1, 2, 3, or 4). If a match is found for the same set of traffic parameters, the row index is returned; otherwise a new table is created and the row index of that CTT row is returned. Since all data TVCs use the same traffic parameters, the same CTT row can be used for all TVCs of a particular service category once it is created.

Note There are no user configurable parameters for the CTT with TVCs.

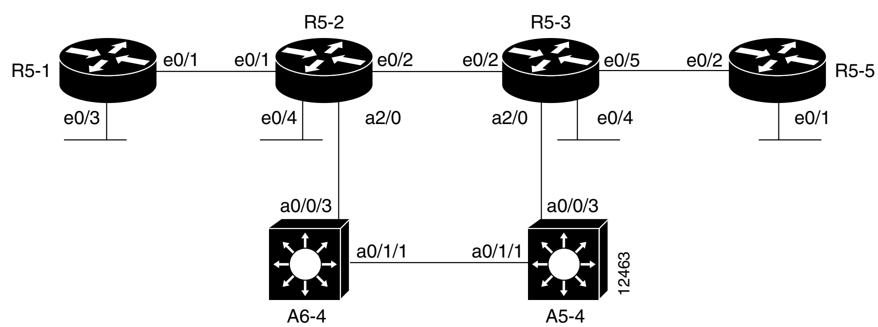
RM CAC Support

Connection admission control (CAC) is not supported for tag virtual channels (TVCs). All TVCs are best effort connections; therefore, no bandwidth is guaranteed by the RS. Only the WRR scheduler is used. So, all of the traffic parameters (PCR, MCR, MBS, CDVT, and SCR) are unspecified. There is no best effort limit like there is with ATM Forum UBR and ABR connections. CAC is bypassed for TVCs.

Tag Switching Configuration Example

Figure 16-4 shows an example tag switching network.

Figure 16-4 Example Network for Tag Switching



Router 5-1 Configuration

The configuration of router R5-1, interface e0/1, follows:

```
router_R5-1# configure terminal
router_R5-2(config)# ip cef switch
router_R5-1(config)# tag-switching advertise-tags
router_R5-1(config)# interface e0/1
router_R5-1(config-if)# tag-switching ip
router_R5-1(config-if)# exit
router_R5-1(config)#
```

Router 5-2 Configuration

The configuration between router R5-1, interface e0/1, and R5-2, interface e0/1, follows:

```
router_R5-2# configure terminal
router_R5-2(config)# ip cef switch
router_R5-2(config)# tag-switching advertise-tags
router_R5-2(config)# interface e0/1
router_R5-2(config-if)# tag-switching ip
router_R5-2(config-if)# exit
router_R5-2(config)#
```

The configuration between router R5-2, interface e0/2, and R5-3, interface e0/2, follows:

```
route_R5-2(config)# interface e0/2
route_R5-2(config-if)# tag-switching ip
route_R5-2(config-if)# exit
```

The configuration of router R5-2, interface a2/0.1, follows:

```
router_R5-2(config-if)# interface a2/0.1
router_R5-2(config-subif)# ip address 189.26.11.15 255.255.0.0
router_R5-2(config-subif)# tag-switching ip
router_R5-2(config-subif)# no shutdown
router_R5-2(config-subif)# exit
router_R5-2(config)# interface a2/0
router_R5-2(config)# no shutdown
```

Router 5-3 Configuration

The configuration of router R5-3, interface e0/2, follows:

```
router_R5-3# configure terminal
router_R5-3(config)# ip cef switch
router_R5-3(config)# tag-switching advertise-tags
router_R5-3(config)# interface e0/2
router_R5-3(config-if)# tag-switching ip
router_R5-3(config-if)# exit
```

The configuration of router R5-3, interface e0/5 follows:

```
router_R5-3(config)# interface e0/5
router_R5-3(config-if)# tag-switching ip
router_R5-3(config-if)# exit
```

The configuration of router R5-3, interface atm 2/0.1, follows:

```
router_R5-3# configure terminal
router_R5-3(config)# interface atm 2/0.1
router_R5-3(config-if)# ip address 189.25.12.13 255.255.0.0
router_R5-3(config-if)# tag-switching ip
router_R5-3(config-if)# no shutdown
router_R5-3(config-if)# exit
router_R5-3(config)# interface a2/0
router_R5-3(config-if)# no shutdown
```

ATM Switch Router A5-4 Configuration

The configuration of ATM switch router A5-4, interfaces atm 0/1/1 and atm 0/0/3, follows:

```
atm_A5-4# configure terminal
atm_A5-4(config)# interface atm 0/1/1
atm_A5-4(config-if)# no shutdown
atm_A5-4(config-if)# ip address 189.24.15.12 255.255.0.0
atm_A5-4(config-if)# tag-switching ip
atm_A5-4(config-if)# exit
atm_A5-4(config)# tag-switching ip
atm_A5-4(config)# interface atm 0/0/3
atm_A5-4(config-if)# no shutdown
atm_A5-4(config-if)# ip address 189.25.15.11 255.255.0.0
atm_A5-4(config-if)# tag-switching ip
atm_A5-4(config-if)# exit
atm_A5-4(config)# tag-switching ip
```

Router 5-5 Configuration

The configuration of router R5-5, interface e0/2, follows:

```
router_R5-5# configure terminal
router_R5-5(config)# ip cef switch
router_R5-5(config)# tag-switching advertise-tags
router_R5-5(config)# interface e0/2
router_R5-5(config-if)# tag-switching ip
router_R5-5(config-if)# exit
```

ATM Switch Router A6-4 Configuration

The configuration of ATM switch router A6-4, interface atm 0/1/1, follows:

```
atm_A6-4# configure terminal
atm_A6-4(config)# interface atm 0/1/1
atm_A6-4(config-if)# no shutdown
```

```
atm_A6-4(config-if)# ip address 189.24.14.12 255.255.0.0
atm_A6-4(config-if)# tag-switching ip
atm_A6-4(config-if)# exit
```

The configuration of ATM switch router A6-4, interface atm 0/0/3, follows:

```
atm_A6-4# configure terminal
atm_A6-4(config)# interface atm 0/0/3
atm_A6-4(config-if)# no shutdown
atm_A6-4(config-if)# ip address 189.26.14.11 255.255.0.0
atm_A6-4(config-if)# tag-switching ip
atm_A6-4(config-if)# exit
```

MPLS Overview

MPLS Label Distribution Protocol (LDP), as standardized by the Internet Engineering Task Force (IETF) and as enabled by Cisco IOS software, allows the construction of highly scalable and flexible IP Virtual Private Networks (VPNs) that support multiple levels of services. MPLS offers the following benefits:

- IP over ATM scalability—Enables service providers to keep up with Internet growth
- IP services over ATM—Brings Layer 2 benefits to Layer 3, such as traffic engineering capability
- Standards—Supports multi-vendor solutions
- Architectural flexibility—Offers choice of ATM or router technology, or a mix of both

This section describes the Multiprotocol Label Switching (MPLS) distribution protocol. MPLS combines the performance and capabilities of Layer 2 (data link layer) switching with the proven scalability of Layer 3 (network layer) routing. This chapter includes the following sections:

- Additional MPLS Documentation
- MPLS Overview
- MPLS Network Packet Transmission
- Configuring Label Edge Routing
- Configuring VPN Networks on Fast Ethernet Interfaces

Obtaining Additional MPLS Documentation

This chapter contains early field test MPLS configuration information for label edge routing (LER) and VPN networks on Fast Ethernet interfaces. For additional MPLS configuration documentation, refer to the sources in Table 16-8.

Table 16-8 Additional MPLS Configuration Documentation

Document	Section	URL
ATM Switch Router Software Configuration Guide	“Configuring Tag Switching”	http://www.cisco.com/univercd/cc/td/doc/product/atm/c8540/12_1/1hous_mt/sw_conf/tag.htm
Layer 3 Switching Software Feature and Configuration Guide	“Tag Switching”	http://www.cisco.com/univercd/cc/td/doc/product/l3sw/8540/12_1/lhouse/sw_confg/8500tags.htm
ATM and Layer 3 Troubleshooting Guide	“Troubleshooting Tag and MPLS Switching Connections”	See PDF Version for EFT documentation
Cisco IOS Switching Services Configuration Guide, Release 12.1	“Multi protocol Label Switching Overview”	http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/switch_c/xcprt4/xcdtagov.htm#xtocid480
Cisco IOS Switching Services Configuration Guide, Release 12.1	“Configuring Multiprotocol Label Switching”	http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/switch_c/xcprt4/xcdtagc.htm#xtocid264140
Cisco IOS Switching Services Configuration Guide, Release 12.1	“Configuring Cisco Express Forwarding”	http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/switch_c/xcprt2/xcdcefc.htm#46064

Hardware and Software Restrictions

The following restrictions or limitations apply to MPLS on the Catalyst 8540, Catalyst 8510 and LightStream 1010:

- MPLS is supported on the Enhanced Gigabit Ethernet, POS, Enhanced ATM router module (1483 PVC), Fast Ethernet, and ATM interfaces

Note Fast Ethernet and ATM interfaces must be linked to an Enhanced ATM router module interface by using the **mpls-forwarding** command to provide MPLS support.

- Traffic Engineering MPLS-QOS is not supported.
- Multicast over MPLS is not supported.
- Access-list based tag advertisements and filtering of MPLS packets based on access-lists are not supported.
- Jumbo frames on MPLS interfaces is not supported.
- Support for EBGP, RIP, OSPF between CE-PE and support for RIP, OSPF, and ISIS between PE-P. In the case of a TC-ATM link between PE-P, only OSPF and ISIS protocols are supported.
- Support IBGP between PE.
- Port-channel cannot be MPLS enabled.
- Port-channel cannot be VRF enabled.

- BVI cannot be MPLS enabled.
- BVI cannot be VRF enabled.
- Statistics at label level are not supported.
- Layer 2 statistics or Layer 3 statistics for ATM interface are not supported.
- When using the **mpls-forwarding** command to link a Fast Ethernet module with shared CAM (content addressable memory) to an ATM router module you can only configure the "master" port (not the "slave" ports) of the Ethernet processor interface. However, once the configuration is applied to the master port the controlling ATM router module performs MPLS and VRF processing for all ports controlled by the Ethernet processor interface (master and slave ports).

Note There is one master port per Ethernet processor interface (which controls four Fast Ethernet interfaces). For example, on an Ethernet processor interface controlling Fast Ethernet interfaces 2/0/0 through 2/0/3, Fast Ethernet interface 2/0/3 is the master port.

MPLS/Tag Switching Terminology

Table 16-9 provides a conversion from the tag switching designations to the equivalent MPLS designations.

Table 16-9 Equivalency Table for Tag Switching and MPLS Terms

Old Tag Switching Terminology	New MPLS IETF Terminology
Tag switching	MPLS (Multiprotocol Label Switching)
Tag (short for tag switching)	MPLS
Tag (item or packet)	Label
TDP (Tag Distribution Protocol)	LDP (Label Distribution Protocol) Cisco TDP and LDP MPLS are nearly identical in function, but use incompatible message formats and some different procedures.
Tag switched	Label switched
TFIB (tag forwarding information base)	LFIB (label forwarding information base)
TSR (tag switch router)	LSR (label switch router)
TSC (tag switched controller)	LSC (label switched controller)
ATM-TSR (ATM tag switch router)	ATM-LSR (ATM label switch router, such as the Cisco BPX 8650 switch)
TVC (tag VC, tag virtual circuit)	LVC (label VC, label virtual circuit)
TSP (tag switch path)	LSP (label-switched path)
XTag ATM (extended Tag ATM) port	XmplsATM (extended MPLS ATM) port

From an historical and functional standpoint, Label Distribution Protocol (LDP) is a superset of the pre-standard Cisco Tag Distribution Protocol (TDP), which also supports MPLS forwarding along normally routed paths. For those features that LDP and TDP share in common, the pattern of protocol exchanges between network routing platforms is identical. The differences between LDP and TDP for those features supported by both protocols are largely embedded in their respective implementation details. For more information on MPLS/tag switching terminology, refer to the *Cisco IOS Switching Services Configuration Guide, Release 12.1*.

How MPLS Works

In conventional Layer 3 forwarding, as a packet traverses the network, each router extracts all the information relevant to forwarding the packet from the Layer 3 header. This information is then used as an index for a routing table lookup to determine the packet's next hop.

In the most common case, the only relevant field in the header is the destination address field, but in some cases other header fields may also be relevant. As a result, the header analysis must be done independently at each router through which the packet passes, and a complicated lookup must also be done at each router.

In MPLS, the analysis of the Layer 3 header is done just once, when the packet enters the network at the ingress LSR (label switch router). This LSR reads the Layer 3 header and inserts a small fixed-format label in front of each data packet. For ATM MPLS connections, the label used is the VPI/VCI of the virtual circuit.The Layer 3 header is then mapped into a fixed length, unstructured value called a label.

Many different headers can map to the same label, as long as those headers always result in the same choice of next hop. In effect, a label represents a forwarding equivalence class—that is, a set of packets, which, however different they may be, are indistinguishable to the forwarding function.

The initial choice of label need not be based exclusively on the contents of the Layer 3 header; it can also be based on policy. This allows forwarding decisions at subsequent hops to be based on policy as well.

Once a label is chosen, a short label header is put at the front of the Layer 3 packet, so that the label value can be carried across the network with the packet. At each subsequent hop, the forwarding decision can be made simply by looking up the label. There is no need to re-analyze the header. Since the label is a fixed length an unstructured value, looking it up is fast and simple.

A label represents a forwarding equivalence class, but it does not represent a particular path through the network. In general, the path through the network continues to be chosen by the existing Layer 3 routing algorithms such as OSPF, Enhanced IGRP, and BGP. That is, at each hop when a label is looked up, the next hop chosen is determined by the dynamic routing algorithm.

The 32-bit MPLS label is located after the Layer 2 header and before the IP header. The MPLS label contains the following fields:

- The label field (20-bits) carries the actual value of the MPLS label.
- The CoS field (3-bits) can affect the queuing and discard algorithms applied to the packet as it is transmitted through the network.
- The Stack (S) field (1-bit) supports a hierarchical label stack.
- The TTL (Time to Live) field (8-bits) provides conventional IP TTL functionality.

The MPLS label is also called a "Shim" header.

Distribution of Label Bindings

Each label switch router (LSR) in the network makes an independent, local decision as to which label value to use to represent an FEC. This association is known as label binding. Each LSR informs its neighbors of the label bindings it has made. This awareness of label bindings by neighboring routers and switches facilitates the following protocols:

- Tag Distribution Protocol (TDP)—Used to support MPLS forwarding along normally routed paths
- Resource Reservation Protocol (RSVP)—Used to support MPLS traffic engineering
- Border Gateway Protocol (BGP)—Used to support MPLS virtual private networks (VPNs)

MPLS LDP provides a standard methodology for hop-by-hop, or dynamic label, distribution in an MPLS network by assigning labels to routes that have been chosen by the underlying Interior Gateway Protocol (IGP) routing protocols. The resulting labeled paths, called label switch paths or LSPs, forward label traffic across an MPLS backbone to particular destinations. These capabilities enable service providers to implement Cisco MPLS-based IP VPNs and IP+ATM services across multi-vendor MPLS networks.

LDP allows label switch routers (LSRs) to request, distribute, and release label prefix binding information to peer routers in a network. LDP enables LSRs to discover potential peers and to establish LDP sessions with those peers to exchange label binding information.

An LDP *label binding* is an association between a destination prefix and a label. The label used in a label binding is allocated from a set of possible labels called a *label space*.

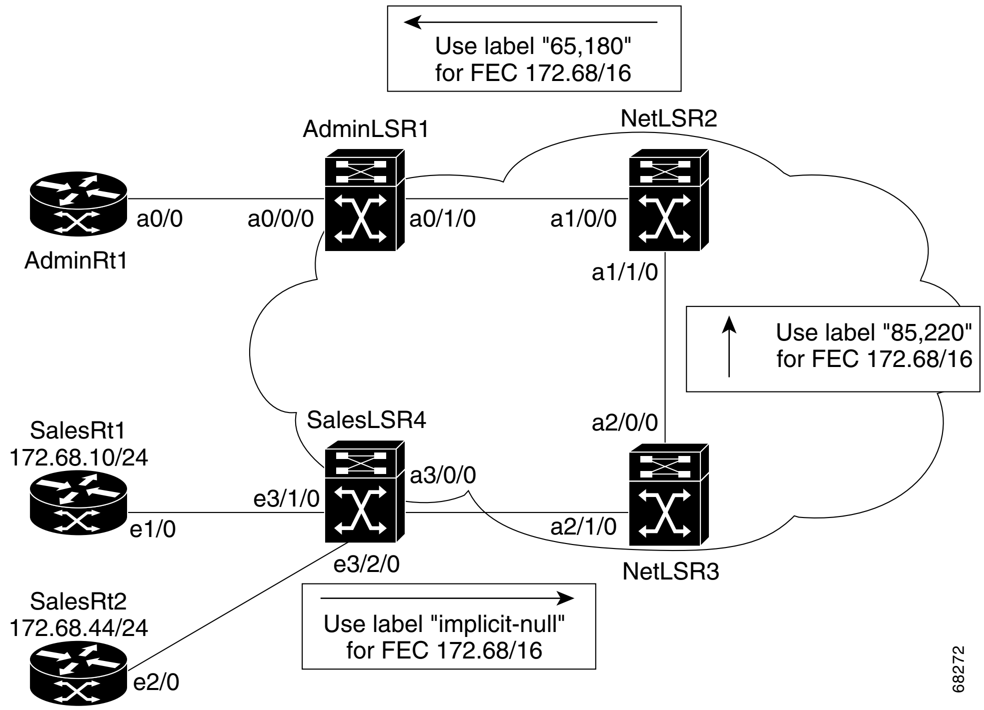
LDP supports two types of label spaces:

- Interface-specific—An interface-specific label space uses interface resources for labels. For example, LC-ATM interfaces use VPIs/VCIs for labels. Depending on its configuration, an LDP platform may support zero, one, or more interface-specific label spaces.
- Platform-wide—An LDP platform supports a single platform-wide label space for use by interfaces that can share the same labels. For Cisco platforms, all interface types except LC-ATM use the platform-wide label space.

Summary Route Propagation

Figure 16-5 shows the summary route propagation between four LSRs in an MPLS network. The LDP discover mechanism is used to periodically transmit LDP hello messages and to signal its desire to advertise label bindings. The LSR sends the LDP hello messages as UDP packets to the well known LDP port (646). The hello messages carry the LDP identifier (ID) of the label space for sending LSR. SalesLSR4 sends a hello packet with the VPI and VCI used to connect to FEC 172.68.0.0. Each LSR then propagates that FEC replacing the VPI and VCI used to connect to its ingress interface.When a labeled packet is being sent from an LSR to its neighbor LSR, the label value carried by the packet is the label value that the egress LSR assigned to represent the FEC of the packet. This causes the label value (VPI/VCI) to be swapped as the packet traverses the network.

Figure 16-5 Summary Route Propagation Between LSRs



LFIB Table Look Up Process

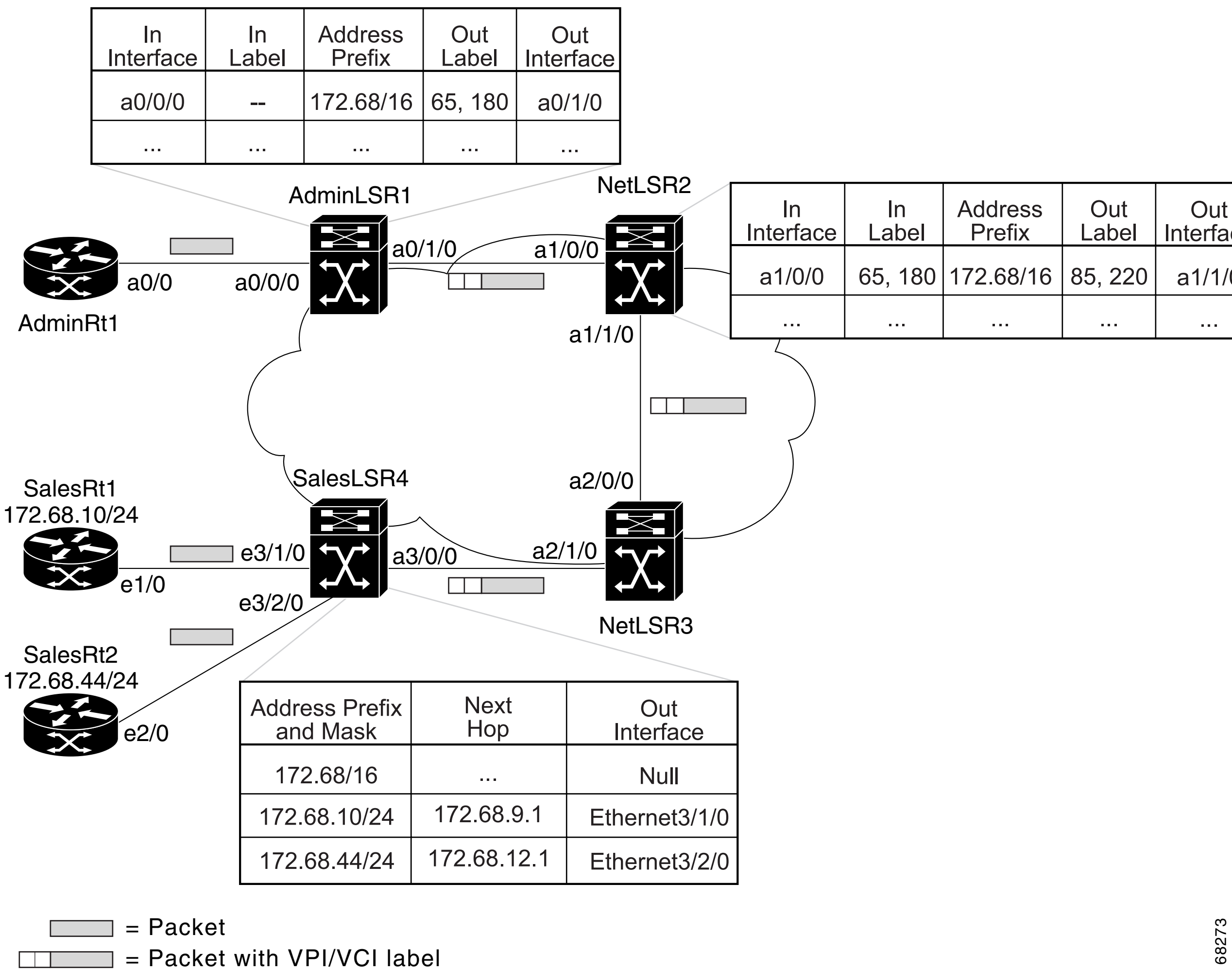
Figure 16-6 shows the packet transmission and LFIB table look up process used between a source and destination over an ATM MPLS network. AdminLSR1 is the ingress point for packets from the router AdminRt1. When the LSR receives the packet it determines the FEC and determines the LSP to use by looking in the LFIB table.

Note The LFIB table is propagated using the LDP discover mechanism shown in Figure 16-5.

AdminLSR1 adds the label (VPI/VCI) 65,180 to the packet and forwards the packet out ATM interface 0/1/0. The intermediate LSR (NetLSR2) takes the labeled packet and pairs the incoming interface and label and then uses a lookup table to determine the outgoing interface and label. After swapping the incoming label with the new outgoing label the packet is forwarded out to the next LSR.

The label swapping process is continued at each LSR until the last LSR. The egress LSR performs the same look up as the intermediate LSRs but the outgoing label is stripped off and the packet is either routed or switched using Layer 3 to its destination.

Figure 16-6 ATM MPLS LFIB Table Update



MPLS Network Packet Transmission

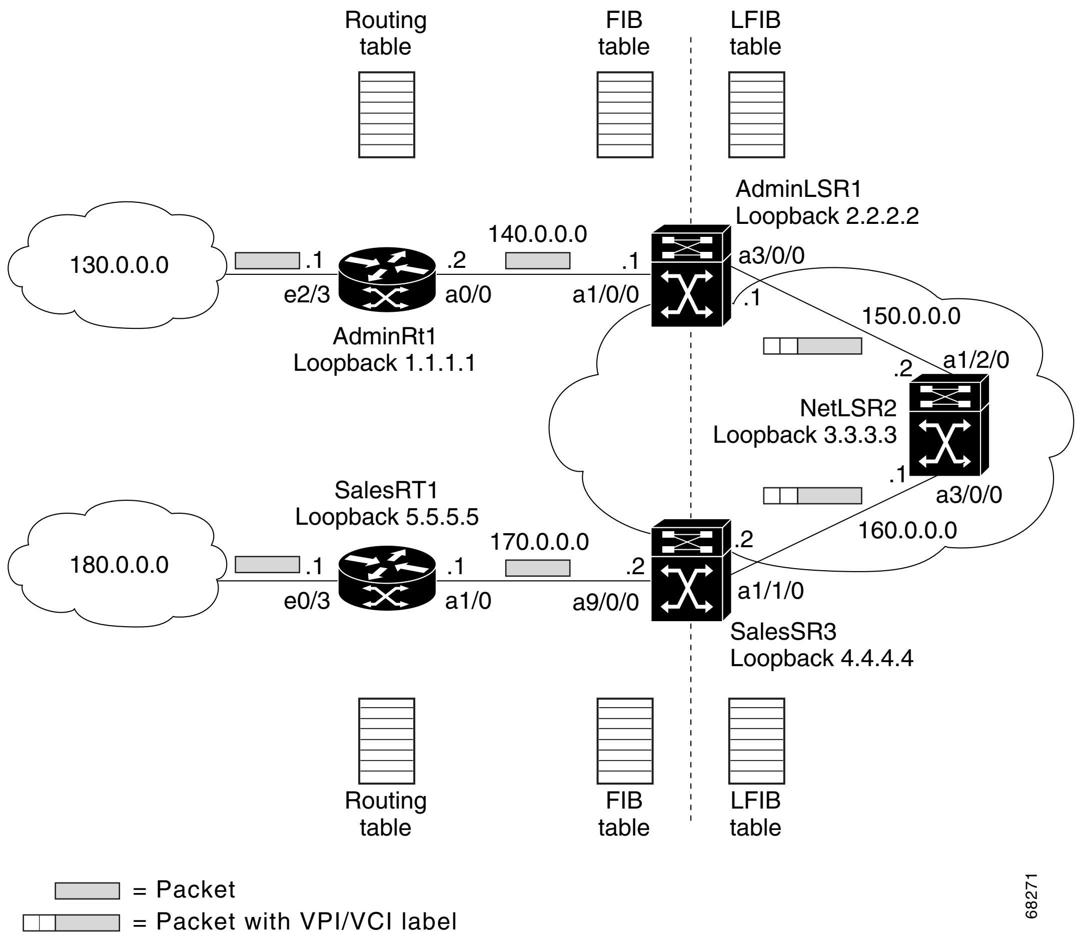
This section provides a description of a packet being transmitted across an MLPS enabled network and the process used to switch the packets.

When a packet is received at an MPLS ingress interface the interface driver uses the IDB (interface descriptor block) to start the following MPLS process on the packet:

- Packet encapsulation is checked and verified
- Packet is checked for QoS or policing limitations.
- Label and ingress interface data are used to check the TFIB trying to determine the egress label and interface number.
- The TTL field is updated and the label is either replaced with the next hop label or popped (deleted) if this is the MPLS edge exit LSR.
- The packet is transmitted to the next hop.

Figure 16-7 shows a packet as it traverse a network from its source on network 130.0.0.0 to its destination on network 180.0.0.0.

Figure 16-7 ATM MPLS Example Network Packet Transmission



The packet from network 130.0.0.0 enters router AdminRt1 at Ethernet interface 2/3 with a destination IP address on network 180.0.0.0. The router preforms a standard routing table lookup and determines the packet should be routed out ATM interface 0/0 to the next hop interface 140.0.0.1 on interface ATM 1/0/0. By using CEF (Cisco Express Forwarding) the Layer 3 switched packet interface FIB (forwarding information base) is queried and the next hop is determined to be out through ATM MPLS interface 3/0/0. Prior to transmission to the next LSR an MPLS label (or VPI/VCI) is appended to the packet just before the destination IP address.

From this point on through the MPLS network, the only information that is checked by the successive LSRs is the label information in the packet. When the packet reaches the edge LSR the MPLS label is popped off and subsequent switching is completed using Layer 3 and standard routing practices.

Configuring Label Edge Routing

This section describes label edge router (LER) for the Cisco Catalyst 8540. With LER, the Cisco Catalyst 8540 can be installed at the edge of a packet- and cell-based network with both or either of them MPLS-enabled. LER also supports multiple TVCs to the same destination prefix and allows a TVC to be selected based upon the CoS value in the incoming label or ToS in the IP packet. The enhanced ATM router module (ARM) serves as the proxy interface for every incoming and outgoing ATM interface (that is linked to an Enhanced ATM router module using the **mpls-forwarding** command) in the LSP path to do the MPLS packet processing. To enable LER functionality, you must first configure tag switching on an ATM interface and link the ATM interface to an ATM router module for MPLS packet processing. For more information on configuring MPLS on ATM interfaces, refer to "Configuring Tag Switching" in the *ATM Switch Router Software Configuration Guide*. For more information on configuring MPLS on Ethernet interfaces, refer to "Configuring Tag Switching" in the *Layer 3 Switching Software and Feature Configuration Guide*.

LER Software Limitations

The following restrictions apply to LER on the Cisco Catalyst 8540:

- The ATM interface (only main interface) can be linked with only the enhanced ATM router module main interface.
- VRF configuration on ATM OC-x interfaces is not supported.
- The COS, LFIB, and Label region in the SDM can be modified using the **sdm sram** command. But, the changes only take effect after a switch reload.
- Load Balancing between provider edge (PE) and provider (P) switches is not supported.
- The SDM SRAM size for LFIB, Label Rewrite, and Label COS region does not increase dynamically when the number of entries increase.

Note To change SDM SRAM configuration you must use the **sdm size** configuration command and the reload command to reconfigure the memory and then halt and perform a cold restart of the switch.

- Packet counters are not implemented for MPLS traffic.
- Forwarding of VPN traffic is based only on the VPN routing table and not on the global routing table. If the VPN routing table lookup fails, the packets will be discarded.
- The Enhanced ATM router module internal link has a maximum capacity of 1.2 Gbps which could affect the number of interfaces—either Fast Ethernet or ATM—associated with the Enhanced ATM router module.
- Only 2k terminating TAG VCs are supported per controlling Enhanced ATM router module hardware interface.
- Fragmentation based on MTU for IP to MPLS and MPLS to MPLS traffic is implemented in the route processors not on the interface modules.

MPLS Processing

To configure LER with the enhanced ATM router module acting as MPLS edge proxy, perform the following steps:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **mpls ip**	Enables MPLS on the ATM interface.
Step 3	Switch(config-if)# **mpls-forwarding interface atm** *card/subcard/port*	Links the specified ATM interface to the enhanced ATM router module interface, which acts as an MPLS edge proxy.

Note You must enable MPLS on the ATM interface by using the **mpls ip** command.

Note Once MPLS is enabled on an ATM interface and the interface is linked to the enhanced ATM router module, all head-end, control, and tail-end VCs through that ATM interface terminate on the Enhanced ATM router module. All MPLS or IP packet processing is performed on the linked Enhanced ATM router module.

Note If you attempt to link an already linked ATM interface to another enhanced ATM router module interface, an error message similar to the following results: `ATM <x/x/x> is already functioning as mpls edge for ATM <y/y/y>.`

Note If you attempt to unlink an ATM interface that is not linked, an error message similar to the following results: `ATM <x/x/x> is not linked to ATM <y/y/y>.`

Example

The following example shows how to link an ATM interface to an enhanced ATM router module interface for LER MPLS functionality:

```
Switch# configure terminal
8540-ATM-PE1(conf)# interface atm 3/0/0
8540-ATM-PE1(conf-if)# mpls ip
8540-ATM-PE1(conf-if)# mpls-forwarding interface atm 10/0/1
```

Tag Switching Processing

To configure LER with the enhanced ATM router module acting as a tag edge proxy, perform the following steps:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **tag switching ip**	Enables mpls on the ATM interface
Step 3	Switch(config-if)# **mpls-forwarding interface atm** *card/subcard/port*	Links the specified ATM interface to the enhanced ATM router module interface, which acts as an MPLS edge proxy.

Note You must enable tag switching on the ATM interface by using the **tag-switching ip** command.

Note Once tag switching is enabled on an ATM interface and the interface is linked to the enhanced ATM router module, all head-end, control, and tail-end VCs through that ATM interface terminate on the enhanced ATM router module. All MPLS/IP packet processing is performed on the linked enhanced ATM router module.

Note If you attempt to link an already linked ATM interface to another enhanced ATM router module interface, an error message similar to the following results: `ATM <x/x/x> is already functioning as mpls edge for ATM <y/y/y>.`

Note If you attempt to unlink an ATM interface that is not linked, an error message similar to the following results: `ATM <x/x/x> is not linked to ATM <y/y/y>.`

Example

The following example shows how to link an ATM interface to an enhanced ATM router module interface for LER MPLS functionality:

```
Switch# configure terminal
8540-ATM-PE1(conf)# interface atm 3/0/0
8540-ATM-PE1(conf-if)# tag-switching ip
8540-ATM-PE1(conf-if)# mpls-forwarding interface atm 10/0/1
```

MPLS Over Fast Ethernet Interfaces

This section describes how to configure MPLS on Fast Ethernet interfaces. By linking a Fast Ethernet interface to an enhanced ATM router module interface, tag or MPLS switching can be enabled on Fast Ethernet interfaces and Fast Ethernet interfaces can be part of a VPN. The enhanced ATM router module (ARM) serves as the MPLS processor on behalf of the Fast Ethernet card. The Fast Ethernet interface forwards all MPLS packets it receives to the enhanced ATM router module. It also forwards all IP packets to the enhanced ATM router module if a VRF is configured on the Fast Ethernet or if the outgoing interface is MPLS-enabled. The enhanced ATM router module processes the packets and forwards them to the appropriate outgoing port.

Note IPX routing and MPLS processing are incompatible. You must remove all IPX routing configuration from the Fast Ethernet interface with which you wish to link, and from all Fast Ethernet interfaces on the interface module controlled by the same Ethernet processor interface, before configuring MPLS. Each Ethernet processor interface controls four Fast Ethernet interfaces on the interface module. On a 16-port Fast Ethernet interface module, ports 0 through 3 are controlled by one Ethernet processor interface, ports 4 through 7 by another, and so forth. For example, if you want to configure an MPLS control link on Fast Ethernet interface 3/0/1, you must remove all IPX configuration from interfaces 3/0/0, 3/0/1, 3/0/2, and 3/0/3.

Configuring MPLS on Fast Ethernet Interfaces

To configure a MPLS for a Fast Ethernet interface, perform the following steps:

	Command	Purpose
Step 1	Switch(config)# **interface fastethernet** *card/subcard/port* Switch(config-if)#	Selects the Fast Ethernet interface to be configured.
Step 2	Switch(config-if)# **mpls-forwarding interface atm** *card/subcard/port*	Links a Fast Ethernet interface to an enhanced ATM router module interface, which performs VPN processing for a Fast Ethernet interface

Example

The following example shows how to configure a Fast Ethernet interface and link it to the enhanced ATM router module for processing:

```
Switch# configure terminal
Switch(conf)# interface fastethernet 3/0/0
Switch(conf-if)# tag-switching ip
Switch(conf-if)# ip address 12.0.0.2 255.0.0.0
Switch(conf-if)# mpls-forwarding interface ATM2/0/0
Switch(conf-if)# end
Switch#
```

MPLS configuration on a Fast Ethernet interface has the following software restrictions:

- Subinterfaces on a Fast Ethernet interface cannot be linked to enhanced ATM router module interfaces.
- VPN can be configured on the Fast Ethernet interface using the **ip vrf forwarding** *vrf-name* command and linking it to an ARM interface using the **mpls-forwarding interface** command.
- The enhanced ATM router module provides efficient MPLS processing for four Fast Ethernet interfaces.
- Pings may fail between an all MPLS configuration of Fast Ethernet interfaces, which are not associated with an active Enhanced ATM router module even though TDP or LDP might comes up and stays up. When the TDP comes up it causes the MPLS tags to be distributed which causes ping packets to reach the Fast Ethernet interfaces as tagged packets but are then dropped.

- Each Fast Ethernet interface can be linked with only one Enhanced ATM router module interface. However, more than one Fast Ethernet interface can be linked with the same Enhanced ATM router module.

MPLS VPNs

This section describes how to configure MPLS VPNs on the ATM switch router.

When used with MPLS, the VPN feature allows several sites to interconnect transparently through a service provider network. One service provider network can support several different IP VPNs. Each of these networks appears to the users as a private network, separate from all other networks. Within a VPN, each site can send IP packets to any other site in the same VPN.

Each VPN is associated with one or more VPN routing or forwarding instances (VRFs). A VRF consists of an IP routing table, a derived Cisco express forwarding (CEF) table, and a set of interfaces that use this forwarding table.

The ATM switch router maintains a separate routing and CEF table for each VRF. This prevents information being sent outside the VPN and allows the same subnet to be used in several VPNs without causing duplicate IP address problems.

For additional MPLS configuration documentation, refer to the sources in Table 16-10.

Table 16-10 Additional MPLS VPN Configuration Documentation

Document	URL
MPLS Virtual Private Networks	http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120t/120t5/vpn.htm
MPLS VPN over ATM: with OSPF on the Customer Side (with Area 0)	http://www.cisco.com/warp/public/121/mpls_ospf2.html
MPLS VPN over ATM: with OSPF on the Customer Side (without Area 0)	http://www.cisco.com/warp/public/121/mpls_ospf1.html
Configuring VPN MPLS over ATM with Cisco 7500 Routers and LightStream 1010 Switches	http://www.cisco.com/warp/public/121/vpn-mpls.html
MPLS VPN over ATM Networks Configuration Examples	http://www.cisco.com/univercd/cc/td/doc/product/vpn/solution/manmpls/overview/configat.htm

This section describes how to configure MPLS VPNs on Fast Ethernet and ATM interfaces. By linking the interface to an enhanced ATM router module interface, tag switching can be enabled on the interfaces and they can be part of a VPN Network. The enhanced ATM Router Module (ARM) serves as the MPLS processor on behalf of the interfaces. The VPN interfaces forward all IP packets they receive from the CE device to the enhanced ATM router module. The enhanced ATM router module processes the packets and forwards them to the appropriate outgoing port.

Note IPX routing and VPN processing are incompatible. You must remove all IPX routing configuration from the Fast Ethernet interface with which you wish to link, and from all Fast Ethernet interfaces on the interface module controlled by the same Ethernet processor interface, before configuring VPN. Each Ethernet processor interface controls four Fast Ethernet interfaces on the interface module. On a 16-port Fast Ethernet interface module, ports 0 through 3 are controlled by one Ethernet processor interface, ports 4 through 7 by another, and so forth. For example, if you want to configure an MPLS control link on Fast Ethernet interface 3/0/1, you must remove all IPX configuration from interfaces 3/0/0, 3/0/1, 3/0/2, and3/0/3.

Configuring VPN on Fast Ethernet Interface

To configure a Fast Ethernet interface as part of an MPLS VPN, perform the following steps:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the Fast Ethernet interface.
Step 2	Switch(config-if)# **ip vrf forwarding** *vrf-name*	Associates a VRF with an interface or subinterface.
Step 3	Switch(config-if)# **ip address** *ip-address mask*	Configures the IP and subnetwork address.
Step 4	Switch(config-if)# **mpls-forwarding interface atm** *card/subcard/port*	Links a Fast Ethernet interface to an enhanced ATM router module interface, which performs MPLS processing for a Fast Ethernet interface

Fast Ethernet Interface Example

The following example shows how to configure the Fast Ethernet interface connected to the customer equipment from the PE ATM switch router and links it to the enhanced ATM router module for processing:

```
8540-ATM-PE1# configure terminal
8540-ATM-PE1(conf)# interface FastEthernet0/0/0
8540-ATM-PE1(conf-if)# ip vrf forwarding vpn1
8540-ATM-PE1(conf-if)# ip address 12.0.0.2 255.0.0.0
8540-ATM-PE1(conf-if)# mpls-forwarding interface ATM2/0/0
8540-ATM-PE1(conf-if)# end
8540-ATM-PE1#
```

Note Subinterfaces on a Fast Ethernet interface cannot be linked to enhanced ATM router module interfaces.

Note MPLS can be configured on the Fast Ethernet interface using the **mpls-forwarding interface** command and by linking it to an enhanced ATM router module interface using the **mpls-forwarding interface** command. The enhanced ATM router module interface should be UP for MPLS processing to work.

Note The enhanced ATM router module provides efficient MPLS processing for four Fast Ethernet interfaces.

Network Configuration Example

Figure 16-8 is an example of an MPLS VPN using ATM switch routers.

Figure 16-8 MPLS VPN Example Network

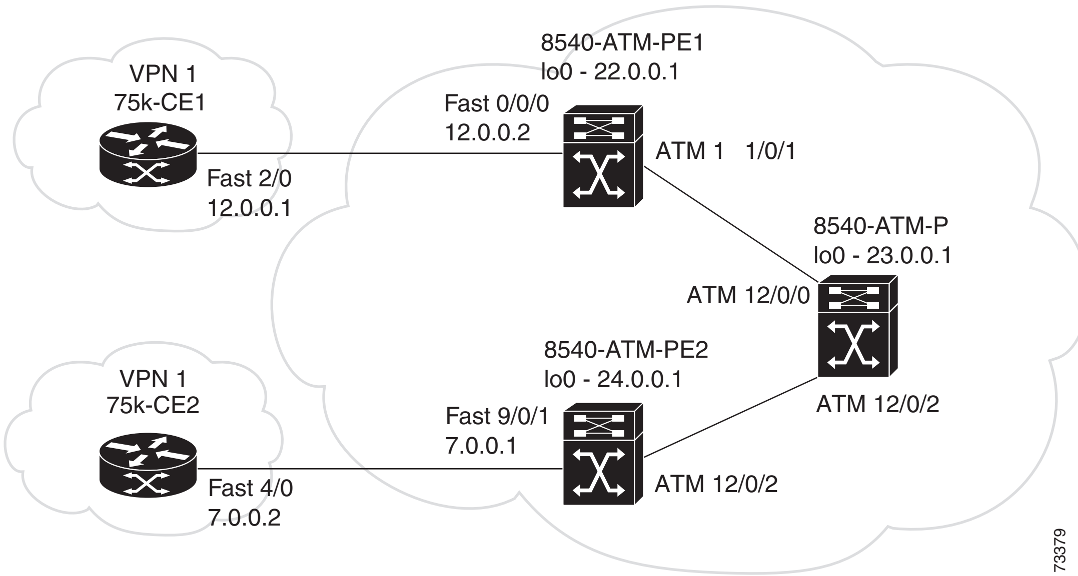


Figure 16-8 shows a VPN using the following routers and ATM switch routers:

- 75k-CE1 and 75k-CE2 are the customer edge devices.
- 8540-ATM-PE1 and 8540-ATM-PE2 are the provider edge devices connecting the customer devices.
- 8540-ATM-P is the provider backbone device.
- The autonomous system numbers are configured as follows:
  - 75k-CE1 is in autonomous system number 104
  - 75k-CE2 is in autonomous system number 105
  - 8540-ATM-PE1 and 8540-ATM-PE2 are configured in autonomous system number 100

Note For this example LDP and IP CEF are running.

75k-CE1 Configuration

The configuration of router 75k-CE1, follows:

```
!
interface FastEthernet2/0
 ip address 12.0.0.1 255.0.0.0
 full-duplex
end
!
```

```
router bgp 104
 bgp log-neighbor-changes
 redistribute connected
 neighbor 12.0.0.2 remote-as 100
!
```

8540-ATM-PE1 Configuration

The configuration of ATM switch router 8540-ATM-PE1, follows:

```
!
ip vrf vpn1
 rd 200:1
 route-target export 200:1
 route-target import 100:1
!
interface Loopback0
 ip address 22.0.0.1 255.255.255.255
end
!
interface FastEthernet0/0/0
 ip vrf forwarding vpn1
 ip address 12.0.0.2 255.0.0.0
 mpls-forwarding interface ATM2/0/0
end
!
interface ATM11/0/1
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
!
router ospf 100
 log-adjacency-changes
network 22.0.0.0 0.255.255.255 area 100
!
!
router bgp 100
 bgp log-neighbor-changes
 neighbor 24.0.0.1 remote-as 100
 neighbor 24.0.0.1 update-source Loopback0
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 neighbor 12.0.0.1 remote-as 104
 neighbor 12.0.0.1 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 24.0.0.1 activate
 neighbor 24.0.0.1 send-community extended
 exit-address-family
!
```

8540-ATM-P Configuration

The configuration of ATM switch router 8540-ATM-P, follows:

```
!
interface Loopback0
 ip address 23.0.0.1 255.255.255.255
end

!
interface ATM12/0/0
ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
interface ATM12/0/2
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
!
router ospf 100
 log-adjacency-changes
network 23.0.0.0 0.255.255.255 area 100
```

8540-ATM-PE2 Configuration

The configuration of ATM switch router 8540-ATM-PE2, follows:

```
!
ip vrf vpn1
 rd 100:1
 route-target export 100:1
 route-target import 200:1

!
interface Loopback0
 ip address 24.0.0.1 255.255.255.255
end

!
interface FastEthernet9/0/1
 ip vrf forwarding vpn1
 ip address 7.0.0.1 255.0.0.0
 mpls-forwarding interface ATM2/0/0
end

!
interface ATM12/0/2
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
```

```
router ospf 100
 log-adjacency-changes
network 24.0.0.0 0.255.255.255 area 100
!

router bgp 100
 bgp log-neighbor-changes
 neighbor 22.0.0.1 remote-as 100
 neighbor 22.0.0.1 update-source Loopback0
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 neighbor 7.0.0.2 remote-as 105
 neighbor 7.0.0.2 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 22.0.0.1 activate
 neighbor 22.0.0.1 send-community extended
 exit-address-family
!
```

75k-CE2 Configuration

The configuration of router 75k-CE2, follows:

```
!
interface FastEthernet4/0
 ip address 7.0.0.2 255.0.0.0
 no ip mroute-cache
 duplex half
end
!
router bgp 105
 bgp log-neighbor-changes
 redistribute connected
 neighbor 7.0.0.1 remote-as 100
!
```

Configuring MPLS VPN Using ATM RFC 1483 Interfaces

Defined in RFC 1483, multiprotocol encapsulation over ATM, provides a mechanisms for carrying traffic other than just IP traffic. RFC 1483 specifies two ways to do this:

- Logical Link Control (LLC)/Subnetwork Access Protocol (SNAP) encapsulation—in this method, multiple protocol types can be carried across a single connection with the type of encapsulated packet identified by a standard LLC/SNAP header.
- Virtual connection multiplexing—in this method, only a single protocol is carried across an ATM connection, with the type of protocol implicitly identified at connection setup.

LLC encapsulation is provided to support routed and bridged protocols. In this encapsulation format, PDUs from multiple protocols can be carried over the same virtual connection. The type of protocol is indicated in the packet SNAP header. By contrast, the virtual connection multiplexing method allows for transport of just one protocol per virtual connection.

To Configure an ATM RFC 1483 MPLS VPN interface on the ATM switch router, perform the following steps:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port.subinterface* **point-to-point** Switch(config-if)#	Creates a point-to-point subinterface.
Step 2	Switch(config-if)# **ip vrf forwarding** *vrf-name*	Associates a VRF with an interface or subinterface.
Step 3	Switch(config-sub-if)# **atm pvc** *vpi-A vci-A* **interface atm** *card/subcard/port vpi-B vci-B*	Creates a PVC to the outgoing ATM interface.
Step 4	Switch(config-if)# **ip address** *ip-address mask*	Assigns an IP address and subnet mask.

Note To configure a VPN on ATM router module multipoint sub-interface, along with the previously mentioned configuration steps you also need to configure a map-list and apply it on the appropriate multipoint subinterface. See Chapter 13, "Configuring IP over ATM," section, "Configuring a PVC-Based Map List" section on page 13-7.

Note To configure a VPN on enhanced ARM interface you can also use the point-to-point subinterface mode instead of the multipoint.

Example

The following example shows how to configure the enhanced ATM router module interface as part of a VPN:

```
8540-ATM-PE1(conf)# interface ATM2/0/0.1 point-to-point
8540-ATM-PE1(conf-if)# ip vrf forwarding vpn1
8540-ATM-PE1(conf-if)# ip address 12.0.0.2 255.0.0.0
8540-ATM-PE1(conf-if)# end
8540-ATM-PE1#
```

The following example shows how to configure the RFC1483 MPLS VPN interface connected to the customer equipment from the PE ATM switch router and cross connected to the enhanced ATM router module interface:

```
8540-ATM-PE1# configure terminal
8540-ATM-PE1(conf)# interface ATM11/0/2
8540-ATM-PE1#
```

The following example shows how to configure the RFC 1483 MPLS VPN interface connected to the provider switch from the PE ATM switch router and cross connected to the enhanced ATM router module interface:

```
8540-ATM-PE1(config)# interface ATM11/0/1
8540-ATM-PE1(conf-if)# ip unnumbered Loopback0
8540-ATM-PE1(conf-if)# tag-switching ip
8540-ATM-PE1(conf-if)# mpls-forwarding interface ATM2/0/0
8540-ATM-PE1(conf-if)# end
8540-ATM-PE1#
```

Network Configuration Example

Figure 16-9 is an example of an MPLS VPN RFC 1483 network using ATM switch routers.

Figure 16-9 MPLS VPN ATM 1483 Example Network

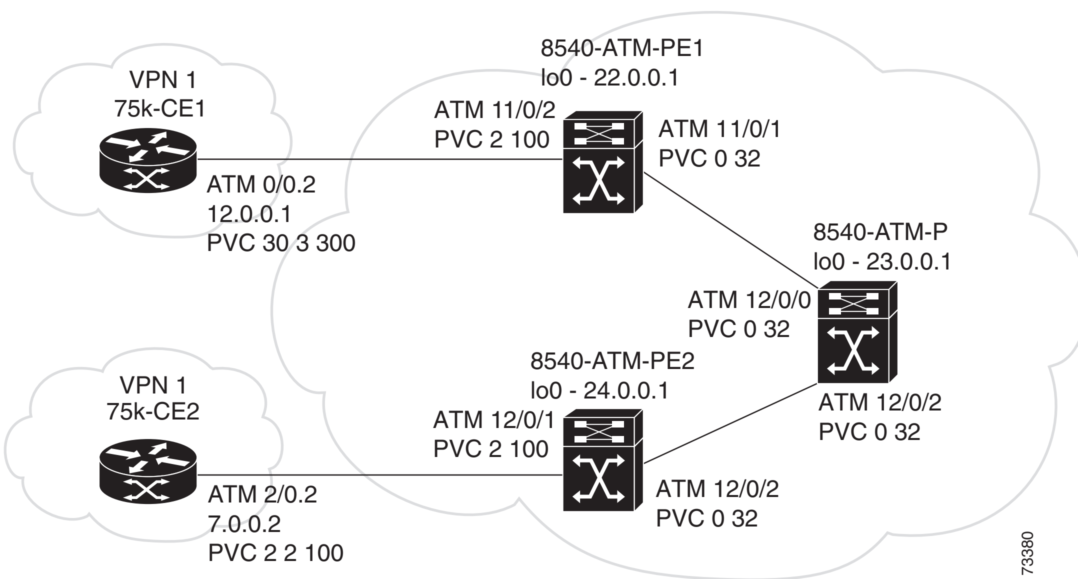


Figure 16-9 shows an RFC 1483 VPN using the following routers and ATM switch routers:

- 75k-CE1 and 75k-CE2 are the customer edge devices.
- 8540-ATM-PE1 and 8540-ATM-PE2 are the provider edge devices connecting the customer devices.
- 8540-ATM-P is the provider backbone device.
- The autonomous system numbers are configured as follows:
  - 75k-CE1 is in autonomous system number 104
  - 75k-CE2 is in autonomous system number 105
  - 8540-ATM-PE1 and 8540-ATM-PE2 are configured in autonomous system number 100

Note For this example LDP and IP CEF are running.

75k-CE1 Configuration

The configuration of router 75k-CE1, follows:

```
!
interface ATM0/0.2 point-to-point
 ip address 12.0.0.1 255.255.0.0
 atm pvc 30 3 300 aal5snap
end
!
router bgp 104
 bgp log-neighbor-changes
 redistribute connected
 neighbor 12.0.0.2 remote-as 100
!
```

8540-ATM-PE1 Configuration

The configuration of ATM switch router 8540-ATM-PE1, follows:

```
!
ip vrf vpn1
 rd 200:1
 route-target export 200:1
 route-target import 100:1

!
interface Loopback0
 ip address 22.0.0.1 255.255.255.255
end
!
!
interface ATM2/0/0.1 point-to-point
 ip vrf forwarding vpn1
 ip address 12.0.0.2 255.0.0.0
end
!
interface ATM11/0/2
 no ip address
 atm pvc 3 300 pd on interface ATM2/0/0.1 2 200 encap aal5snap
 logging event subif-link-status
 no atm ilmi-keepalive
end
!

interface ATM11/0/1
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
!
router ospf 100
 log-adjacency-changes
network 22.0.0.0 0.255.255.255 area 100
!
```

```
!
router bgp 100
 bgp log-neighbor-changes
 neighbor 24.0.0.1 remote-as 100
 neighbor 24.0.0.1 update-source Loopback0
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 neighbor 12.0.0.1 remote-as 104
 neighbor 12.0.0.1 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 24.0.0.1 activate
 neighbor 24.0.0.1 send-community extended
 exit-address-family
!
```

8540-ATM-P Configuration

The configuration of ATM switch router 8540-ATM-P, follows:

```
!
interface Loopback0
 ip address 23.0.0.1 255.255.255.255
end

!
interface ATM12/0/0
ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
interface ATM12/0/2
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
 tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!
!
router ospf 100
 log-adjacency-changes
network 23.0.0.0 0.255.255.255 area 100
```

8540-ATM-PE2 Configuration

The configuration of ATM switch router 8540-ATM-PE2, follows:

```
!
ip vrf vpn1
 rd 100:1
 route-target export 100:1
 route-target import 200:1

!
```

```
interface Loopback0
 ip address 24.0.0.1 255.255.255.255
end

!
interface ATM2/0/0.1 point-to-point
 ip vrf forwarding vpn1
 ip address 7.0.0.1 255.0.0.0
end
!
!
interface ATM12/0/1
 no ip address
 atm pvc 2 100 pd on interface ATM2/0/0.1 2 200 encap aal5snap
 logging event subif-link-status
 clock source free-running
 no atm ilmi-keepalive
end
!
!
interface ATM12/0/2
 ip unnumbered Loopback0
 logging event subif-link-status
 no atm ilmi-keepalive
  tag-switching ip
 mpls-forwarding interface ATM2/0/0
end
!

router ospf 100
 log-adjacency-changes
network 24.0.0.0 0.255.255.255 area 100
!

router bgp 100
 bgp log-neighbor-changes
 neighbor 22.0.0.1 remote-as 100
 neighbor 22.0.0.1 update-source Loopback0
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 neighbor 7.0.0.2 remote-as 105
 neighbor 7.0.0.2 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 22.0.0.1 activate
 neighbor 22.0.0.1 send-community extended
 exit-address-family
!
```

75k-CE2 Configuration

The configuration of router 75k-CE2, follows:

```
!
interface ATM2/0.2 point-to-point
 ip address 7.0.0.2 255.0.0.0
 atm pvc 2 2 100 aal5snap
end
```

```
!
!
router bgp 105
 bgp log-neighbor-changes
 redistribute connected
 neighbor 7.0.0.1 remote-as 100
!
```

Configuring Signalling Features

This chapter describes signalling-related features and their configuration for the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For general information about ATM signalling protocols, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Configuring Signalling IE Forwarding

You enable signalling information element (IE) forwarding of the specified IE from the calling party to the called party.

Note The default is to transfer all the information elements in the signalling message.

To configure interface signalling IE transfer, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **atm signalling ie forward** {**aal-info** | **all** | **bli-repeat-ind** | **called-subaddress** | **calling-number** | **higher-layer-info** | **lower-layer-info** | **unknown-ie**}	Configures the signalling information element forwarding.

Example

The following example shows how to disable signalling of all forwarded IEs on ATM interface 0/0/0:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# no atm signalling ie forward all
```

Displaying the Interface Signalling IE Forwarding Configuration

To display the interface signalling IE forwarding configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the interface signalling IE forwarding configuration.

Example

The following example displays the modified configuration of the signalling IE forwarding:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
<information deleted>
!
interface ATM0/0/0
 no atm signallling ie forward calling-number
 no atm signallling ie forward calling-subaddress
 no atm signallling ie forward called-subaddress
 no atm signallling ie forward higher-layer-info
 no atm signallling ie forward lower-layer-info
 no atm signallling ie forward blli-repeat-ind
 no atm signallling ie forward aal-info
!
<information deleted>
```

Configuring ATM SVC Frame Discard

You can select the criteria used to install frame discard on switched virtual channels (SVCs). The default is to install packet discard based on the presence of the ATM adaptation layer 5 (AAL5) information element in the SETUP message.

Note The term *frame discard* is referred to as *packet discard* on ATM switch router virtual circuits.

You can use this global configuration function to modify frame discard for all connections.

To configure frame discard, use the following command in global configuration mode:

Command	Purpose
atm svc-frame-discard-on-aal5ie	Configures the SVC frame discard.

This command changes the information that the ATM switch router uses to decide whether or not to install frame discard on SVCs. User-Network Interface (UNI) 4.0 signalling allows for explicit signalling of frame discard. Pre-UNI 4.0 versions use the presence of the AAL5 information elements to determine whether or not to install frame discard. If the AAL5 information element is present, frame discard is installed; otherwise it is not, as shown in the following example.

- When you configure **atm svc-frame-discard-on-aal5ie**, frame discard is installed if the AAL5 information element is present.
- When you configure **no atm svc-frame-discard-on-aal5ie**, frame discard is installed on UNI 4 or PNNI interfaces if explicitly requested by the SETUP and CONNECT messages.

Example

In the following example, the ATM switch router behavior is set to not use the AAL5 information element to dictate frame discard.

```
Switch(config)# no atm svc-frame-discard-on-aal5ie
```

Displaying the ATM Frame Discard Configuration

To display the ATM frame discard configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the frame discard configuration.

Example

The following example shows how to display the frame discard configuration:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
network-clock-select 1 ATM0/0/0
network-clock-select 4 ATM0/0/0
ip host-routing
no atm svc-frame-discard-on-aal5ie
!
<information deleted>
```

Configuring E.164 Addresses

E.164 support allows networks that use network service access point (NSAP) ATM addresses formats (for example, 45.000001234567777F00000000.000000000000.00) to work with networks that use E.164 address formats (for example, 1–123–456–7777). For an overview of address types and E.164 subtypes, refer to the *Guide to ATM Technology*.

The following sections describe configuring E.164 support:

- E.164 Conversion Methods, page 17-5
- Configuring E.164 Gateway, page 17-5
- Configuring E.164 Address Autoconversion, page 17-8
- Configuring E.164 Address One-to-One Translation Table, page 17-9

E.164 Conversion Methods

There are three features you can configure on the ATM switch router for E.164 address conversion. The feature you chose depends on the address format you are using. The features are as follows:

- E.164 gateway—Use this feature when addresses are in international code designator (ICD) or data country code (DCC) format and a call must traverse an E.164 network.
- E.164 address autoconversion—Use this feature when addresses are in E164_ZDSP or E.164_AESA format and a call must traverse an E.164 network. An E.164_AESA uses the ATM end system address (AESA) format with the E.164 number embedded; an E164_ZDSP is an E164_AESA address with all zeros after the embedded E.164 number; for example, 45.000001234567777F00000000.000000000000.00.
- E.164 address one-to-one translation table—Use this feature when you want to create an E.164 to AESA address translation table manually. This feature is not recommended for most networks.

Caution Manually creating the E.164 to AESA address translation table is a time consuming and error prone process. We strongly recommend that you use either the E.164 gateway or E.164 autoconversion feature instead of the E.164 one-to-one address translation feature.

Configuring E.164 Gateway

The E.164 gateway feature allows calls with AESAs to be forwarded, based on prefix matching, on interfaces that are statically mapped to E.164 addresses. To configure the E.164 gateway feature, you must first configure a static ATM route with an E.164 address, then configure the E.164 address to use on the interface.

When a static route is configured on an interface, all ATM addresses that match the configured address prefix are routed through that interface to an E.164 address.

Signalling uses E.164 addresses in the called and calling party IEs, and uses AESAs in the called and calling party subaddress IEs. For a detailed description of how the E.164 gateway feature works, refer to the *Guide to ATM Technology*.

Note Enter access lists for E.164 addresses in the E164_AESA format, not native E.164 format. For example, if the E.164 address is 7654321, then the E164_AESA format is 45.000000007654321F00000000.000000000000.00. To filter prefix “765”, enter the prefix 45.00000000765..., not just 765.... Access lists operate on the called and calling party IEs. See Chapter 12, “Using Access Control.”

Configuring an E.164 Address Static Route

To configure an E.164 address static route, use the following command in global configuration mode:

Command	Purpose
atm route *address-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** {**international** | **local** | **national** | **subscriber**}]] [**internal**] [**scope** *org-scope*]	At the configure prompt, configures the static route prefix with the E.164 address.

Example

The following example uses the **atm route** command to configure a static route using the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 with the E.164 address 1234567:

```
Switch(config)# atm route 47.00918100000000410B0A1081 atm 0/0/0 e164-address 7654321
```

To complete the E.164 address static route configuration, proceed to the "Configuring an ATM E.164 Address on an Interface" section on page 17-6.

Displaying the E.164 Static Route Configuration

To display the E.164 address configuration, use the following privileged EXEC command:

Command	Purpose
show atm route	Displays the static route E.164 address configuration.

Example

The following example displays the E.164 address configuration using the **show atm route** privileged EXEC command:

```
Switch# show atm route
Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)
P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E 1   ATM0/1/0     DN 0   47.0091.8100.0000.0001/72
P SI 1   0            UP 0   47.0091.8100.0000.0002.eb1f.fe00/104
R  I 1   ATM2/0/0     UP 0   47.0091.8100.0000.0002.eb1f.fe00.0002.eb1f.fe00/152
R  I 1   ATM2/0/0     UP 0   47.0091.8100.0000.0002.eb1f.fe00.4000.0c/128
P SI 1   0            UP 0   47.0091.8100.0000.0040.0b0a.2b81/104
S  E 1   ATM0/0/0     DN 0   47.0091.8100.0000.0040.0b0a.2b81/104
                             (E164 Address 1234567)
R  I 1   ATM2/0/0     UP 0   47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81/152
R  I 1   ATM2/0/0     UP 0   47.0091.8100.0000.0040.0b0a.2b81.4000.0c/128
```

Configuring an ATM E.164 Address on an Interface

One E.164 address can be configured per ATM port. Signalling uses E.164 addresses in the called and calling party IEs, and uses AESA addresses in the called and calling party subaddress IEs.

To configure an E.164 address on a per-interface basis, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects an interface port.
Step 2	Switch(config-if)# **atm e164 address** *e164-address*	Associates the E.164 address to the interface.

Example

The following example shows how to configure the E.164 address 7654321 on ATM interface 0/0/1:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm e164 address 7654321
```

Displaying the E.164 Address Association to Interface Configuration

To display the E.164 configuration, use the following EXEC command:

Command	Purpose
show atm interface atm *card/subcard/port*	Shows the E.164 address configuration on a per-port basis.

Example

The following example shows how to display the E.164 address configuration for ATM interface 0/0/1:

```
Switch# show atm interface atm 0/0/1

Interface:       ATM0/0/1        Port-type:    oc3suni
IF Status:       UP              Admin Status: up
Auto-config:     enabled         AutoCfgState: completed
IF-Side:         Network         IF-type:      NNI
Uni-type:        not applicable  Uni-version:  not applicable
Max-VPI-bits:    8               Max-VCI-bits: 14
Max-VP:          255             Max-VC:       16383
ConfMaxSvpcVpi: 255              CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255              CurrMaxSvccVpi: 255
ConfMinSvccVci: 35               CurrMinSvccVci: 35
Svc Upc Intent: pass             Signalling:   Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0010.00
➔ ATM E164 Address: 7654321
<information deleted>
```

When the E.164 gateway feature is configured, the switch first attempts to make a connection using the E.164 gateway feature. If that connection fails, the switch attempts to make the connection using the E.164 address autoconversion feature, described in the following section.

Configuring E.164 Address Autoconversion

If your network uses E164_ZDSP or E164_AESA addresses, you can configure E.164 address autoconversion. The E164_ZDSP and E164_AESA addresses include an embedded E.164 number in the E.164 portion of an E.164 ATM address. This embedded E.164 number is used in the autoconversion process.

For a detailed description of the E.164 autoconversion feature and differences in the autoconversion process between the E164_ZDSP and E164_AESA address formats, refer to the *Guide to ATM Technology*.

Note Enter access lists for E.164 addresses in the E164_AESA format, not the native E.164 format. For example, if the E.164 address is 7654321, then the E164_AESA format is 45.000000007654321F00000000.000000000000.00. To filter prefix "765," enter the prefix 45.00000000765..., not just 765.... Access lists operate on the called and calling party IEs. See Chapter 12, "Using Access Control.".

E.164 address autoconversion configuration is the same, regardless of which type of address (E164_ZDSP or E164_AESA) your network uses. To configure E.164 address autoconversion, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm route** *address-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** {**international** | **local** | **national** | **subscriber**}]] [**internal**] [**scope** *org-scope*]	At the configure prompt, configures the static route prefix with the E.164 address.
Step 2	Switch(config-if)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the ATM interface.
Step 3	Switch(config-if)# **atm e164 auto-conversion**	Configures E.164 autoconversion.
Step 4	Switch(config-if)# **exit** Switch(config)#	Returns to global configuration mode.

Examples

In the following example a static route is configured on interface 0/0/1 using the ATM address of the ATM switch router on the opposite side of the E.164 public network; E.164 autoconversion is also enabled:

```
Switch(config)# atm route 45.000007654321111F atm 0/0/1
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm e164 auto-conversion
```

The converse configuration is done at the ATM switch router across the E.164 network; a static route is configured to the ATM address of the above switch, and E.164 autoconversion is enabled:

```
Switch(config)# atm route 45.000001234567777F atm 0/0/1
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm e164 auto-conversion
```

Displaying the E.164 Address Autoconversion

To display the E.164 configuration on an interface, use the following EXEC command:

Command	Purpose
show atm interface atm *card/subcard/port*	Shows the E.164 address configuration on a per-port basis.

Example

The following example shows how to display the E.164 configuration for ATM interface 0/0/1:

```
Switch# show atm interface atm 0/0/1

Interface:      ATM0/0/1        Port-type:      oc3suni
IF Status:      DOWN            Admin Status:   down
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        Network         IF-type:        UNI
Uni-type:       Private         Uni-version:    V3.0
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 33              CurrMinSvccVci: 33
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0002.eb1f.fe00.4000.0c80.0010.00
ATM E164 Auto Conversion Interface
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      2        0       0       0       0        0       0          2          0
Logical ports(VP-tunnels):     0
Input cells:    0               Output cells:   0
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 0, Output AAL5 pkts: 0, AAL5 crc errors: 0
```

Configuring E.164 Address One-to-One Translation Table

The ATM interface to a public network commonly uses an E.164 address for ATM signalling, with international code designator (ICD) or data country code (DCC) format AESA addresses carried in the subaddress fields of the message. The one-to-one translation table allows signalling to look up the E.164 addresses and the AESA addresses in a database, allowing a one-to-one correspondence between AESA addresses and E.164 addresses.

Caution Manually mapping AESA addresses to E.164 addresses is a time consuming and error prone process. We highly recommend that you use either the E.164 gateway or E.164 autoconversion feature instead of the E.164 one-to-one address translation feature.

For a detailed explanation of how the E.164 translation table feature works, refer to the *Guide to ATM Technology*.

Configuring one-to-one E.164 translation tables requires the following steps:

Step 1 Configure specific ATM interface(s) to connect to E.164 public networks to use the translation table.

Step 2 Configure the translation table.

Step 3 Add entries to the translation table for both the called and calling parties.

To configure E.164 translation on the interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects an interface port.
Step 2	Switch(config-if)# **atm e164 translation**	Configures the ATM E.164 interface.
Step 3	Switch(config-if)# **exit** Switch(config)#	Returns to EXEC configuration mode.
Step 4	Switch(config)# **atm e164 translation-table** Switch(config-atm-e164)#	Changes to E.164 ATM configuration mode.
Step 5	Switch(config-atm-e164)# **e164 address** *address* **nsap-address**[1] *nsap-address*	Configures the E.164 translation table.

1. The NSAP address is the same as the ARB_AESA address.

Example

The following example shows how to configure the ATM interface 0/0/1 to use the one-to-one E.164 translation table and specifies three table entries:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm e164 translation
Switch(config-if)# exit
Switch(config)# atm e164 translation-table
Switch(config-atm-e164)# e164 address 1111111 nsap-address 11.1111111111111111111111111.112233445566.11
Switch(config-atm-e164)# e164 address 2222222 nsap-address 22.2222222222222222222222222.112233445566.22
Switch(config-atm-e164)# e164 address 3333333 nsap-address 33.3333333333333333333333333.112233445566.33
```

Displaying the ATM E.164 Translation Table Configuration

To display the ATM E.164 translation table configuration, use the following privileged EXEC commands:

Command	Purpose
more system:running-config	Displays the E.164 translation table configuration.
show atm interface atm *card/subcard/port*	Displays the E.164 address configuration on a per-port basis.

Example

The following example shows how to display the E.164 translation table configuration:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
atm e164 translation-table
 e164 address 1111111 nsap-address 11.111111111111111111111111.112233445566.11
 e164 address 2222222 nsap-address 22.222222222222222222222222.112233445566.22
 e164 address 3333333 nsap-address 33.333333333333333333333333.112233445566.33
!
atm service-category-limit cbr 64544
atm service-category-limit vbr-rt 64544
atm service-category-limit vbr-nrt 64544
atm service-category-limit abr-ubr 64544
atm address 47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81.00
!
<information deleted>
```

Example

The following example shows how to display the E.164 configuration for ATM interface 0/0/1:

```
Switch# show atm interface atm 0/0/1

Interface:      ATM0/0/1        Port-type:    oc3suni
IF Status:      DOWN            Admin Status: administratively down
Auto-config:    enabled         AutoCfgState: waiting for response from peer
IF-Side:        Network         IF-type:      UNI
Uni-type:       Private         Uni-version:  V3.0
Max-VPI-bits:   8               Max-VCI-bits: 14
Max-VP:         255             Max-VC:       16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:   Enabled
ATM Address for Soft VC: 47.9999.9999.0000.0000.0000.0216.4000.0c80.0010.00
ATM E164 Translation Interface
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   PVPLs SoftVPLs   SVPLs  Total-Cfgd  Installed-Conns
      2        0       0       0        0       0           2                0
Logical ports(VP-tunnels):      0
Input cells:    0               Output cells: 0
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 0, Output AAL5 pkts: 0, AAL5 crc errors: 0
```

Configuring Signalling Diagnostics Tables

Signalling diagnostics enable you to diagnose a specific call failure in your network and pinpoint the location of the call failure along with the reason for the failure. To do this, you must configure a signalling diagnostics table that stores the filtering criteria and a filter index, an integer value between

1 and 50, used to uniquely identify each set of filtering criteria you select. Each filtering criteria occupies one entry in the signalling diagnostics table. Each entry in the filter table is entered using command-line interface (CLI) commands or Simple Network Management Protocol (SNMP). Then the diagnostics software module, when enabled, filters rejected calls based on the entries in your filter table. A successful match in the filter table causes the rejected call information to be stored for analysis.

Note Signalling diagnostics is a tool for troubleshooting failed calls and should not be enabled during normal operation of the ATM switch router.

To configure the signalling diagnostics table entries, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm signalling diagnostics enable**	Enables ATM signalling diagnostics.
Step 2	Switch(config)# **atm signalling diagnostics** *index* Switch(config-atmsig-diag)#	Changes to ATM signalling diagnostics configuration mode.
Step 3	Switch(config-atmsig-diag)# **age-timer** *seconds*	Configures the timeout value for the entry, in seconds.
Step 4	Switch(config-atmsig-diag)# **called-nsap-address** *nsap-address*	Configures a filtering criteria based on the called NSAP address of the rejected call.
Step 5	Switch(config-atmsig-diag)# **called-address-mask** *nsap-address-mask*[1]	Configures a filtering criteria based on the called address mask value used to identify the valid bits of the calling NSAP address of the rejected call.
Step 6	Switch(config-atmsig-diag)# **calling-nsap-address** *nsap-address*	Configures a filtering criteria based on the calling NSAP address of the rejected call.
Step 7	Switch(config-atmsig-diag)# **atm signalling diagnostics enable**	Enables ATM signalling diagnostics.
Step 8	Switch(config-atmsig-diag)# **clear-cause** *clear-cause-code*[2]	Configures a filtering criteria based on the cleared cause code of the rejected call.
Step 9	Switch(config-atmsig-diag)# **connection-category** {**soft-vc** | **soft-vp** | **reg-vc** | **all**}	Configures a filtering criteria based on the VC connection category of the rejected call.
Step 10	Switch(config-atmsig-diag)# **incoming-port atm** *card***/***subcard***/***port*	Configures a filtering criteria based on the incoming port of the rejected call.
Step 11	Switch(config-atmsig-diag)# **outgoing-port atm** *card***/***subcard***/***port*	Configures a filtering criteria based on the outgoing port of the rejected call.
Step 12	Switch(config-atmsig-diag)# **max-records** *max-num-records*	Configures the maximum number of entries to be stored in the display table for each of the entries in the filter table.
Step 13	Switch(config-atmsig-diag)# **purge**	Purges all the filtered records in the filter table.
Step 14	Switch(config-atmsig-diag)# **scope** {**internal** | **external**}	Configures a filtering criteria based on the scope of the rejected call which either failed internally in the switch or externally on other switches.

	Command	Purpose
Step 15	Switch(config-atmsig-diag)# **service-category** {**cbr** | **abr** | **vbr-rt** | **vbr-nrt** | **ubr** | **all**}	Configures a filtering criteria based on the service category of the rejected call.
Step 16	Switch(config-atmsig-diag)# **status** [**active** *filter-criteria* | **inactive** *filter-criteria* | **delete** *filter-criteria*]	Configures the status of the entry in the filter table.

1. The combination of the configured *calling_addr_mask* (*called_address_mask*) and the configured *calling_nsap_address* (*called_nsap_address*) are used to filter the rejected call.
2. You can obtain the cause code values from the ATM forum UNI3.1 specification.

The display table contains the records that were collected based on every filtering criteria in the filter table. Each filtering criteria has only a specified number of records that are stored in the table. After that specified number of records is exceeded, the table is overwritten.

Examples

The following example shows how to enable signalling diagnostics on the ATM switch router:

```
Switch(config)# atm signalling diagnostics enable
```

The following example shows how to change to signalling diagnostics mode on the ATM switch router:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)#
```

The following example shows how to specify the timeout value for the entry in seconds:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# age-timer 3600
```

The following example shows how to configure filter criteria for calls rejected based on the called NSAP address of the call:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# called-nsap-address 47.0091810000000061705BD901.010203040506.0
```

The following example shows how to configure filter criteria for calls rejected based on the called address mask of the call:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# called-address-mask ff.ff.ff.00
```

The following example shows how to configure filter criteria for calls rejected based on the connection type:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# cast-type p2p p2mp
```

The following example shows how to configure the filter entry for filtering failed calls based on the clear cause value 3 (destination unreachable):

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# clearcause 3
```

The following example shows how to configure filter criteria for call failures based on the category of the virtual circuit:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# connection-category soft-vc
Switch(cfg-atmsig-diag)# connection-category soft-vc soft-vp
```

The following example shows how to configure the filter entry for filtering failed calls that came in through ATM interface 1/1/1:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# incoming-port atm. 1/1/1
```

The following example shows how to configure the filter entry for filtering failed calls that went out through ATM interface 1/1/1:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# outgoing-port atm 1/1/1
```

The following example shows how to specify the maximum number of entries to be stored in the display table for each of the entries in the filter table:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# max-records 40
```

The following example shows how to purge all the filtered records corresponding to this entry in the filter table:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# purge
```

The following example shows how to configure filter criteria for calls that failed internally in the switch:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# scope internal
```

The following example shows how to configure filter criteria in signalling diagnostics index 1 for call failures based on the service category:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# service-category cbr
Switch(cfg-atmsig-diag)# service-category ubr
Switch(cfg-atmsig-diag)# service-category abr ubr
```

The following example shows how to delete an index entry in the filter table:

```
Switch(config)# atm signalling diagnostics 1
Switch(cfg-atmsig-diag)# status delete
```

Displaying the Signalling Diagnostics Table Configuration

To display the signalling diagnostics information, use the following EXEC commands:

Command	Purpose
show atm signalling diagnostics record *filter-index*	Displays the ATM signalling diagnostics for a record.
show atm signalling diagnostics filter [*filter-index*]	Displays the ATM signalling diagnostics for a filter.
show atm signalling diagnostics status	Displays the ATM signalling diagnostic status.

Examples

The following example shows the signalling diagnostic records for index 1:

```
Switch# show atm signalling diagnostics record 1
D I S P L A Y   I N D E X  1
--------------------------------
Scope: internal,  Cast Type: p2p, Conn Indicator: Setup Failure
Connection Kind:   switched-vc
Service Category:  UBR (Unspecified Bit Rate)
Clear Cause: 0x29,  Diagnostics: NULL
Incoming Port: ATM1/0/3,  Outgoing Port:ATM0/1/3
Calling-Address: 47.00918100000000601100000.470803040506.00
Calling-SubAddr: NULL
Called-Address : 47.009181000000006083C42C01.750203040506.00
Called-SubAddr : NULL
Crankback Type : No Crankback
DTL's :
NodeId:56:160:47.00918100000000601100000.006083AB9001.00 Port: 0/1/3:2
NodeId:56:160:47.00918100000000603E7B4101.00603E7B4101.00 Port: 0/0/0:2
NodeId:56:160:47.009181000000006083C42C01.006083C42C01.00 Port: 0
```

The following example shows the signalling diagnostics data for filter index 1:

```
Switch# show atm signalling diagnostics filter 1
F I L T E R   I N D E X   1
------------------------------
Scope: internal, Cast Type: p2mp
Connection Kind: soft-vc
Service Category:  CBR (Constant Bit Rate)  UBR (Unspecified Bit Rate)
Clear Cause: 0, Initial TimerValue: 600
Max Records: 20,   NumMatches: 0,   Timer expiry: 600
Incoming Port: ATM0/0/1, Outgoing Port: ATM0/1/1
Calling Nsap Address:47.111122223333444455556666.777788889999.00
Calling Address Mask:FF.FFFFFF000000000000000000.000000000000.00
Called Nsap Address :47.111122223333444455556666.777788889999.01
Called Address Mask :FF.FFFFFF000000000000000000.000000000000.00
Status : active
```

The following example shows the signalling diagnostics status:

```
Switch# show atm signalling diagnostics status
   Signalling diagnostics disabled globally
```

Configuring Closed User Group Signalling

You can configure closed user groups (CUGs) on the ATM switch router to form restricted access groups that function as ATM virtual private networks (VPNs). Access restrictions for users are configured through CUG interlock codes. For a description of how CUGs work using signalling, and an example of CUGs, refer to the *Guide to ATM Technology*.

Configuring a CUG is described in the following sections:

- Configuring Aliases for CUG Interlock Codes, page 17-16
- Configuring CUG on an Interface, page 17-16
- Displaying the CUG, page 17-17

Configuring Aliases for CUG Interlock Codes

You can define an alias for each CUG interlock code used on the ATM switch router. Using an alias can simplify configuration of a CUG on multiple interfaces. When you use an alias, you no longer need to specify the 48-hexadecimal-digit CUG interlock code on each interface attached to a CUG member.

To configure an alias for a CUG interlock code, use the following command in global configuration mode:

Command	Purpose
atm signalling cug alias *alias-name* **interlock-code** *interlock-code*	Configures the alias for the CUG interlock code.

Example

The following example shows how to configure the alias TEST for the CUG interlock code 4700918100000000603E5A790100603E5A790100.12345678:

```
Switch(config)# atm signalling cug alias TEST interlock-code
4700918100000000603E5A790100603E5A790100.12345678
```

Configuring CUG on an Interface

Your first step in CUG configuration is to identify the *access interfaces*. Transmission and reception of CUG interlock codes is not allowed over access interfaces. Configuring all interfaces leading outside of the network as access interfaces ensures that all CUG interlock codes are generated and used only within this network.

You implement CUG procedures only if you configure the interface as an access interface.

Each access interface can be configured to permit or deny calls either *from* users attached to this interface or *to* unknown users who are not members of this interface's CUGs. In International Telecommunications Union Telecommunications Standardization Sector (ITU-T) terminology, this is called *outgoing access*. Similarly, each access interface can be configured to permit or deny calls either *to* the users attached to this interface or *from* unknown users who are not members of this interface's CUGs. In ITU-T terminology, this is called *incoming access*.

Note Interfaces to other networks should be configured as CUG access interfaces, even if no CUGs are configured on the interface. In this case, if you want the ATM switch router to exchange SVCs with the neighbor network, calls *to* and *from* unknown users should be permitted on the interface.

You can configure each access interface to have one or more CUGs associated with it, but only one CUG can be selected as the *preferential* CUG. In this software release, calls received *from* users attached to this interface can only be associated with the preferential CUG. Calls destined *to* users attached to this interface can be accepted based on membership in any of the CUGs configured for the interface.

Note You can configure CUG service without any preferential CUG. If a preferential CUG is not configured on the interface, and calls *from* users attached to this interface *to* unknown users are permitted, the calls will proceed as non-CUG calls, without generating any CUG IEs.

For each CUG configured on the interface, you can specify that calls *to* or *from* other members of the same CUG be denied. In ITU-T terminology, this is called *outgoing-calls-barred* (OCB) and *incoming-calls-barred* (ICB), respectively.

Table 17-1 describes the relationship between the ITU-T CUG terminology and Cisco CUG terminology.

Table 17-1 Cisco CUG and ITU-T CUG Terminology Conversion

ITU-T CUG Terminology	Cisco CUG Terminology
preferential CUG	preferential
incoming access allowed	permit-unknown-cugs to-user
outgoing access allowed	permit-unknown-cugs from-user
incoming calls barred (ICB)	deny-same-cug to-user
outgoing calls barred (OCB)	deny-same-cug from-user

To configure an access interface and the CUGs in which the interface is a member, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enter interface configuration mode.
Step 2	Switch(config-if)# **atm signalling cug access** [**permit-unknown-cugs** {**to-user** | **from-user permanent** | **both-directions permanent**}]	Configures the interface as a CUG access interface.
Step 3	Switch(config-if)# **atm signalling cug assign** {**alias** *alias-name* | **interlock-code** *interlock-code*} [**deny-same-cug** {**to-user** | **from-user**}] [**preferential**]	Configures the CUG where this interface is a member.

Example

The following example shows how to configure an interface as a CUG access interface and assign a preferential CUG:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm signalling cug access permit-unknown-cugs both-direction permanent
Switch(config-if)# atm signalling cug assign interlock-code
4700918100000000603E5A790100603E5A790100.12345678 preferential
```

Displaying the CUG

To display the global CUG configuration, use the following privileged EXEC commands:

Command	Purpose
show atm signalling cug [**interface atm** *card/subcard/port*] [**access** | **alias** *alias-name* | **interlock-code** *interlock-code*]	Displays the CUG interface configuration status.
more system:running-config	Displays the CUG global configuration status.

Examples

The following example displays the global CUG configuration using the **show atm signalling cug** EXEC command:

```
Switch# show atm signalling cug
Interface:          ATM3/0/0
Cug Alias Name:
Cug Interlock Code: 47009181000000000603E5A790100603E5A790100.12345678
Non preferential Cug
Permit Network to User Calls
Permit User to Network Calls
```

The following example displays the global CUG access configuration using the **show atm signalling cug access** command:

```
Switch# show atm signalling cug access
Closed User Group Access Interface Parameters:


Interface:          ATM3/0/0
Network To User (incoming) access: Permit calls from unknown CUGs to User
User To Network (outgoing) access: Permit permanent calls to unknown groups
```

The following example displays the CUG global configuration using the **more system:running-config** command:

```
Switch# more system:running-config
Building configuration...
Current configuration:
!
version XX.X
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname ls1010-2
!
atm signalling cug alias TEST interlock-code
47.0091810000000061705BDA01.0061705BDA01.00.12345678
!
atm address 47.0091.8100.0000.0061.705b.da01.0061.705b.da01.00

<information deleted>
!
interface ATM0/0/0
 atm signalling cug access permit-unknown-cugs both-direction permanent
<information deleted>
```

Displaying the Signalling Statistics

To display the ATM signalling statistics, use the following EXEC command:

Command	Purpose
show atm signalling statistics	Displays the ATM signalling statistics.

Example

The following example displays the ATM signalling statistics:

```
Switch# show atm signalling statistics
Global Statistics:
Calls Throttled: 0
Max Crankback: 3
Max Connections Pending: 255
Max Connections Pending Hi Water Mark: 1
ATM0:0   UP Time 01:06:20  # of int resets: 0
----------------------------------------------------------------
Terminating connections: 0       Soft VCs: 0
Active Transit PTP SVC: 0        Active Transit MTP SVC: 0
Port requests:  0                Source route requests: 0
Conn-Pending: 0                  Conn-Pending High Water Mark: 1
Calls Throttled: 0               Max-Conn-Pending:  40
          Messages:   Incoming  Outgoing
          ---------   --------  --------
PTP Setup Messages:        0         0
MTP Setup Messages:        0         0
  Release Messages:        0         0
  Restart Messages:        0         0
           Message:   Received Transmitted Tx-Reject Rx-Reject
Add Party Messages:          0           0         0         0
     Failure Cause:   Routing     CAC   Access-list    Addr-Reg  Misc-Failure
    Location Local:         0       0             0           0         12334
   Location Remote:         0       0             0           0             0
ATM 0/0/3:0   UP Time 3d21h  # of int resets: 0
----------------------------------------------------------------
Terminating connections: 0       Soft VCs: 0
Active Transit PTP SVC: 0        Active Transit MTP SVC: 0
Port requests:  0                Source route requests: 0
Conn-Pending: 0                  Conn-Pending High Water Mark: 0
Calls Throttled: 0               Max-Conn-Pending:  40

<information deleted>
```

Disabling Signalling on an Interface

If you disable signalling on a Private Network-Network Interface (PNNI) interface, PNNI routing is also disabled and Integrated Local Management Interface (ILMI) is automatically restarted whenever signalling is enabled or disabled.

To disable signalling on an interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **no atm signalling enable**	Disables signalling on the interface.

Example

The following example shows how to shut down signalling on ATM interface 0/1/2:

```
Switch(config)# interface atm 0/1/2
Switch(config-if)# no atm signalling enable
Switch(config-if)#
%ATM-5-ATMSOFTSTART: Restarting ATM signalling and ILMI on ATM0/1/2.
```

Multipoint-to-Point Funnel Signalling

Multipoint-to-point funnel signalling (funneling) merges multiple incoming switched virtual channels (SVCs) into a single outgoing SVC. This feature supports the Microsoft Corporation Proprietary Funnel Join (or Flow Merge) Protocol.

No configuration is necessary to enable this feature. For a complete description, refer to the *Guide to ATM Technology*.

Displaying Multipoint-to-Point Funnel Connections

To display multipoint-to-point funnel connections, use the following EXEC commands:

Command	Purpose
show atm status	Displays the number of active funnels.
show atm vc cast mp2p	Displays the status of the multipoint-to-point messages on the specific interfaces.

Examples

Use the **show atm status** command to display the number of active funnels, point-to-point and point-to-multipoint setup messages. An example of the **show atm status** command output follows:

```
Switch# show atm status
NUMBER OF INSTALLED CONNECTIONS: (P2P=Point to Point, P2MP=Point to MultiPoint,
MP2P=Multipoint to Point)
Type      PVCs SoftPVCs      SVCs      TVCs      PVPs SoftPVPs      SVPs       Total
P2P        26         0         0         0         2         0         0          28
P2MP        1         0         0         0         0         0         0           1
MP2P        0         0         1         0         0         0         0           1
                                      TOTAL INSTALLED CONNECTIONS =          30
PER-INTERFACE STATUS SUMMARY AT 13:34:48 UTC Thu Jan 29 1998:
   Interface       IF         Admin  Auto-Cfg    ILMI Addr      SSCOP    Hello
     Name       Status      Status    Status    Reg State      State    State
------------- -------- ------------ -------- ------------ --------- --------
ATM0/0/0            UP           up     done  UpAndNormal    Active 2way_in
ATM0/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM0/0/2            UP           up     done  UpAndNormal    Active 2way_in
ATM0/0/3            UP           up     done  UpAndNormal    Active 2way_in
ATM0/0/3.55         UP           up  waiting  WaitDevType      Idle      n/a
ATM0/0/3.60         UP           up  waiting  WaitDevType      Idle      n/a
ATM0/0/3.65         UP           up  waiting  WaitDevType      Idle      n/a
ATM0/1/0            UP           up      n/a  UpAndNormal    Active      n/a
ATM0/1/1            UP           up     done  UpAndNormal    Active      n/a
ATM0/1/2          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/3          DOWN         down  waiting          n/a      Idle      n/a
```

Use the **show atm vc cast mp2p** command to display the status of the multipoint-to-point messages on the specific interfaces. An example of the **show atm vc cast mp2p** command output follows:

```
Switch# show atm vc cast mp2p
Interface     VPI   VCI   Type    X-Interface  X-VPI X-VCI  Encap Status
ATM0/1/0      0     40     SVC     ATM0/1/1     0     35            UP
                                   ATM0/1/1     0     36            UP
ATM0/1/1      0     35     SVC     ATM0/1/0     0     40            UP
ATM0/1/1      0     36     SVC     ATM0/1/0     0     40            UP
```

CHAPTER 18

Configuring Interfaces

This chapter describes the steps required to configure the physical interfaces on the ATM switch router. Your switch is configured as specified in your order and is ready for installation and startup when it leaves the factory.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For hardware installation and cabling instructions, refer to the *ATM and Layer 3 Port Adapter and Interface Module Installation Guide*.

Each port on the interface module or interface module physical interface can be configured to support the following clocking options:

- Self-timing based on a stratum 4 level clock
- Loop timing from the received data stream—ideal for public network connections
- Timing synchronized to a selected master clock port; required to distribute a single clock across a network

The plug-and-play mechanisms of the ATM switch router allow it to come up automatically. All configuration information for interface modules can be saved between hot swaps and switch router reboots. The switch router automatically discovers interface types and eliminates mandatory manual configuration.

When you upgrade your system, add components, or customize the initial configuration, see the following sections:

- Configuring 25-Mbps Interfaces (Catalyst 8510 MSR and LightStream 1010), page 18-2
- Configuring 155-Mbps SM, MM, and UTP Interfaces, page 18-3
- Configuring OC-3c MMF Interfaces (Catalyst 8540 MSR), page 18-5
- Configuring 622-Mbps SM and MM Interfaces, page 18-6
- Configuring OC-12c SM and MM Interfaces (Catalyst 8540 MSR), page 18-9
- Configuring OC-48c SM and MM Interfaces (Catalyst 8540 MSR), page 18-11
- Configuring DS3 and E3 Interfaces, page 18-13
- Configuring T1/E1 Trunk Interfaces, page 18-15
- Troubleshooting the Interface Configuration, page 18-17

Note For hardware installation and cabling instructions, refer to the *ATM Port Adapter and Interface Module Installation Guide*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

To configure the circuit emulation service (CES) T1 and E1 port adapters, see Chapter 19, "Configuring Circuit Emulation Services." To configure the Frame Relay E1 port adapters, see Chapter 20, "Configuring Frame Relay to ATM Interworking Port Adapter Interfaces." To configure the T1 and E1 inverse multiplexing over ATM (IMA) port adapters, see Chapter 21, "Configuring IMA Port Adapter Interfaces." To configure the ATM router modules, see Chapter 25, "Configuring ATM Router Module Interfaces."

Configuring 25-Mbps Interfaces (Catalyst 8510 MSR and LightStream 1010)

The ATM switch supports two types of 25-Mbps port adapters: a 4-port version and a 12-port version. The number of ports is determined by the type of cable used with the 25-Mbps port adapters. The cables have a 96-pin Molex connector with a multileg RJ-45 cable assembly. That is, multiple RJ-45 cables branch off from one large 96-pin Molex connector. You can choose either a 4-port version (with four RJ-45 cables) or a 12-port version (with 12 RJ-45 cables). Each 25.6-Mbps ATM port can be used for workgroup links. Each port complies with the ATM Forum PHY standard for 25.6 Mbps over twisted-pair cable.

The plug-and-play mechanisms of the ATM switch allow the switches to come up automatically. All configuration information for the port adapters can be saved between hot swaps and switch reboots, while interface types are automatically discovered by the switch, thereby eliminating mandatory manual configuration.

The ATM switch supports any combination of port adapters. You can configure your switch with up to 32 25-Mbps interface ports with the 4-port 25-Mbps port adapter, or up to 96 25-Mbps interface ports with the 12-port 25-Mbps port adapter.

Default 25-Mbps ATM Interface Configuration without Autoconfiguration (Catalyst 8510 MSR and LightStream 1010)

If ILMI is disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all 25-Mbps interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 2
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private

For the 12-port 25-Mbps port adapter, the following parameters can be configured on physical ports 0 or 6. Parameters configured on port 0 apply to ports 0 to 5, and parameters configured on port 6 apply to ports 6 to 11. For the 4-port 25-Mbps port adapter, parameters configured on port 0 apply to ports 0 to 4:

- Output-queue
- Output-threshold
- CAC link sharing

Note Pacing might not be configured on any physical port of the 25-Mbps port adapter.

Manual 25-Mbps Interface Configuration (Catalyst 8510 MSR and LightStream 1010)

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side network**] [**type private**] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.

Example

The following example shows how to change the default ATM interface type to private, using the **atm uni type private** command:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm uni type private
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring 155-Mbps SM, MM, and UTP Interfaces

The 155-Mbps Synchronous Optical Network (SONET) Synchronous Transport Signal level 3/Synchronous Digital Hierarchy (STS3c/SDH) Synchronous Transport Module level 1 (STM1) port adapter, used for intercampus or wide-area links, has four ports.

155-Mbps Interface Configuration

You can configure any number and type of interfaces required, up to 64 155-Mbps interface ports on the Catalyst 8540 MSR and up to 32 155-Mbps interface ports on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers.

Note The 155-Mbps port adapter supports mixed mode. Port 0 is a single-mode interface and ports 1 through 3 are multimode interfaces.

The port adapter supports SC-type and unshielded twisted-pair (UTP) connectors, while receive and transmit LEDs on each port give quick, visual indications of port status and operation.

Traffic pacing allows the aggregate output traffic rate on any port to be set to a rate below the line rate. This feature is useful when communicating with a slow receiver or when connected to public networks with peak-rate tariffs.

Default 155-Mbps ATM Interface Configuration without Autoconfiguration

If Integrated Local Management Interface (ILMI) has been disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all 155-Mbps interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum virtual path identifier (VPI) bits = 8
- Maximum virtual channel identifier (VCI) bits = 14
- ATM interface side = network
- ATM UNI type = private
- Framing = sts-3c
- Clock source = network-derived
- Synchronous Transfer Signal (STS) stream scrambling = on
- Cell payload scrambling = on

Manual 155-Mbps Interface Configuration

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side** {**network** | **user**}] [**type** {**private** | **public**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 5	Switch(config-if)# **sonet** {**stm-1** | **sts-3c**}	Modifies the framing mode.

	Command	Purpose
Step 6	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 7	Switch(config-if)# **scrambling** {**cell-payload** | **sts-stream**}	Modifies the scrambling mode.

Example

The following example configures ATM interface 3/1/1 as the network side of a private UNI running version 3.1.

```
Switch# interface atm 3/1/1
Switch(config-if)# no atm auto-configuration
Switch(config-if)#
%ATM-6ILMIOAUTOCFG: ILMI(ATM/0/0): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
Switch(config-if)# atm uni version 3.1
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring OC-3c MMF Interfaces (Catalyst 8540 MSR)

The 16-port OC-3c MMF interface module provides short-reach intercampus and WAN ATM connections. The OC-3c interface module provides an interface to ATM switching fabrics for transmitting and receiving data bidirectionally at up to 155 Mbps. The OC-3c interface module can support interfaces that connect to the OC-3c MMF STS-3c/STM1 physical layer.

The Catalyst 8540 MSR supports up to eight OC-3c interface modules per chassis, with a maximum of 128 OC-3c interface ports.

Note You can configure traffic pacing on the interfaces to allow the aggregate output traffic rate on any interface to be set to a rate below the line rate. This feature is useful when communicating with a slow receiver or when connected to public networks with peak-rate tariffs.

Default OC-3c MMF Interface Configuration without Autoconfiguration (Catalyst 8540 MSR)

If Integrated Local Management Interface (ILMI) has been disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all OC-3c interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum virtual path identifier (VPI) bits = 8
- Maximum virtual channel identifier (VCI) bits = 14
- ATM interface side = network
- ATM UNI type = private
- Framing = sts-3c
- Clock source = network-derived

- Synchronous Transfer Signal (STS) stream scrambling = on
- Cell payload scrambling = on

Manual OC-3c MMF Interface Configuration (Catalyst 8540 MSR)

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side** {**private** | **public**}] [**type** {**network** | **user**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 5	Switch(config-if)# **sonet** {**stm-1** | **sts-3c**}	Modifies the framing mode.
Step 6	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 7	Switch(config-if)# **scrambling** {**cell-payload** | **sts-stream**}	Modifies the scrambling mode.

Example

The following example configures ATM interface 3/0/1 as the network side of a private UNI running version 3.1.

```
Switch# interface atm 3/0/1
Switch(config-if)# no atm auto-configuration
Switch(config-if)#
%ATM-6-ILMINOAUTOCFG: ILMI(ATM3/0/1): Auto-configuration is disabled, current interface
parameters will be used at next interface restart.
Switch(config-if)# atm uni version 3.1
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring 622-Mbps SM and MM Interfaces

These interfaces are used for intercampus or wide-area links.

The 622-Mbps SONET STS12/SDH STM4 port adapter has a single port. You can configure your switch with only the number and type of interfaces required, with up to eight 622-Mbps interface ports.

Note The configuration instructions in this section also apply to the ATM Fabric Integration Module.

The port adapter supports an SC-type connector, and receive and transmit LEDs give quick, visual indications of port status and operation.

Default 622-Mbps ATM Interface Configuration without Autoconfiguration

If ILMI has been disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all 622-Mbps interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 8
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private
- Framing = sts-12c
- Clock source = network-derived
- STS stream scrambling = on
- Cell payload scrambling = on
- Reporting alarms = SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA
- Path trace message = free format 64-byte string containing path information
- Scrambling = On
- BER thresholds: SF = 10e-3 SD = 10e-6
- TCA thresholds: B1 = 10e-6 B2 = 10e-6 B3 = 10e-6

Manual 622-Mbps Interface Configuration

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port*[1] Switch(config-if)#	Specifies the ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side** {**network** | **user**}] [**type** {**private** | **public**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 5	Switch(config-if)# **sonet** {**stm-4c** | **sts-12c**} or Switch(config-if)# **framing** {**stm-4c** | **sts-12c**}	Modifies the framing mode.
Step 6	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 7	Switch(config-if)# **sonet overhead** {**c2** *bytes* | **j0** {*bytes* | **msg** *line*} | **j1** {**16byte** {**exp-msg** *line* | **msg** *line*} | **64byte** {**exp-msg** *line* | **msg** *line*}} | **s1s0** *bits*}	Modifies the path trace message.
Step 8	Switch(config-if)# **sonet threshold** {**sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**} *ber*	Modifies the bit error rate threshold value from 3 (10e-3) to 9 (10e-9).
Step 9	Switch(config-if)# **sonet report** {**slos** | **slof** | **lais** | **lrdi** | **pais** | **prdi** | **plop** | **sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**}	Enables reporting of selected alarms.

1. The subcard for the full-width 622-Mbps interface module is always zero.

Examples

The following example shows how to change the default ATM interface type to **private** using the **atm uni type private** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm uni type private
```

The following example shows how to change the clock source using the **clock source network-derived** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# clock source network-derived
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring OC-12c SM and MM Interfaces (Catalyst 8540 MSR)

The 4-port OC-12c SM and MM interface modules provide either single-mode or multimode intermediate reach. The OC-12c interface module provides an interface to ATM switching fabrics for transmitting and receiving data bidirectionally at up to 622 Mbps. The OC-12c interface module can support interfaces that connect to the OC-12c SONET STS12/SDH STM4 physical layer.

These interfaces are used for intercampus or wide-area links.

Note The configuration instructions in this section also apply to the ATM Fabric Integration Module.

OC-12c Interface Configuration (Catalyst 8540 MSR)

The full-width four-port 622-Mbps is available in either a single-mode intermediate reach interface module or a new multimode module.You can configure your Catalyst 8540 MSR with only the number and type of interfaces required, up to 32 622-Mbps interface ports using the full-width interface module.

The interface module supports an SC-type connector, and receive and transmit LEDs give quick, visual indications of port status and operation.

Default OC-12c ATM Interface Configuration without Autoconfiguration (Catalyst 8540 MSR)

If ILMI has been disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all OC-12c interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 8
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private
- Framing = sts-12c
- Clock source = network-derived
- STS stream scrambling = on
- Cell payload scrambling = on
- Reporting alarms = SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA
- Path trace message = free format 64-byte string containing path information
- Scrambling = On
- BER thresholds: SF = 10e-3 SD = 10e-6
- TCA thresholds: B1 = 10e-6 B2 = 10e-6 B3 = 10e-6

Manual OC-12c Interface Configuration (Catalyst 8540 MSR)

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port*[1] Switch(config-if)#	Specifies the ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side** {**network** | **user**}] [**type** {**private** | **public**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 5	Switch(config-if)# **sonet** {**stm-4c** | **sts-12c**} or Switch(config-if)# **framing** {**stm-4c** | **sts-12c**}	Modifies the framing mode.
Step 6	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 7	Switch(config-if)# **sonet overhead** {**c2** *bytes* | **j0** {*bytes* | **msg** *line*} | **j1** {**16byte** {**exp-msg** *line* | **msg** *line*} | **64byte** {**exp-msg** *line* | **msg** *line*}} | **s1s0** *bits*}	Modifies the path trace message.
Step 8	Switch(config-if)# **sonet threshold** {**sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**} *ber*	Modifies the bit error rate threshold value from 3 (10e-3) to 9 (10e-9).
Step 9	Switch(config-if)# **sonet report** {**slos** | **slof** | **lais** | **lrdi** | **pais** | **prdi** | **plop** | **sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**}	Enables reporting of selected alarms.

1. The subcard for the full-width 622-Mbps interface module is always zero.

Examples

The following example shows how to change the default ATM interface type to **private** using the **atm uni type private** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm uni type private
```

The following example shows how to change the clock source using the **clock source network-derived** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# clock source network-derived
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring OC-48c SM and MM Interfaces (Catalyst 8540 MSR)

The Catalyst 8540 MSR supports the following three OC-48c SM and MM intermediate reach fiber interface modules:

- 1-port OC-48c single-mode intermediate reach *plus* 4-port OC-12 single-mode fiber
- 1-port OC-48c single-mode intermediate reach *plus* 4-port OC-12 multimode fiber
- 2-port OC-48c single-mode intermediate reach
- 1-port OC-48c single-mode long reach *plus* 4-port OC-12 single-mode fiber
- 2-port OC-48c single-mode long reach

Each OC-48c interface module occupies a slot pair. For example, install an OC-48c interface module in slots 0 and 1, 2 and 3, 9 and 10, or 11 and 12. The chassis supports a maximum of four OC-48c interface modules. A maximum configuration provides up to four OC-48c ports and 16 OC-12 ports or up to eight OC-48c ports. The OC-48c interface module supports a dual SC-type connector. Refer to your hardware installation guide for more information.

The OC-48c interface module is used for intercampus or wide-area links. This interface module is functionally similar to the current OC-3c and OC-12c interfaces, but operates at a faster speed. OC-48c supports both UNI and NNI as well as all framing options.

Default OC-48c ATM Interface Configuration Without Autoconfiguration (Catalyst 8540 MSR)

If ILMI is disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all OC-48c interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 8
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private
- Framing = sts-48c
- Loopback = no loopback
- STS stream scrambling = on
- Cell payload scrambling = on
- Clock source = network-derived
- Reporting alarms enabled = SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA
- Path trace message = free format 64-byte string containing path information
- Bit error rate (BER) thresholds: SF = 10e-3, SD = 10e-6
- TCA thresholds: B1 = 10e-6, B2 = 10e-6, B3 = 10e-6

Manual OC-48c Interface Configuration (Catalyst 8540 MSR)

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies the ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm uni** [**side** {**network** | **user**}] [**type** {**private** | **public**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 3	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 4	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 5	Switch(config-if)# **sonet** {**stm-16** | **sts-48c**}	Modifies the framing mode.
Step 6	Switch(config-if)# **clock source** {**free-running** | **loop-timed network-derived**}	Modifies the clock source.
Step 7	Switch(config-if)# **sonet overhead** {**c2** *bytes* | **j0** {*bytes* | **msg** *line*} | **j1** {**16byte** {**exp-msg** *line* | **msg** *line*} | **64byte** {**exp-msg** *line* | **msg** *line*}} | **s1s0** *bits*}	Modifies the path trace message.
Step 8	Switch(config-if)# **sonet threshold** {**sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**} *ber*	Modifies the BER threshold values.
Step 9	Switch(config-if)# **sonet report** {**slos** | **slof** | **lais** | **lrdi** | **pais** | **prdi** | **plop** | **sd-ber** | **sf-ber** | **b1-tca** | **b2-tca** | **b3-tca**}	Enables reporting of selected alarms.

Example

The following example shows how to change the number of active VCI bits to 12:

```
Switch(config)# interface atm 9/0/0
Switch(config-if)# atm max-vci-bits 12
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring DS3 and E3 Interfaces

The 45-Mbps DS3 and the 34-Mbps E3 port adapters are used for wide-area connections, to link multiple campuses, or to connect to public networks.

DS3 and E3 Interface Configuration

You can configure your switch router with only the number and type of interfaces required, with up to 64 DS3 or E3 interface ports on the Catalyst 8540 MSR and up to 32 DS3 or E3 interface ports on the Catalyst 8510 MSR and LightStream 1010 ATM switch router.

Traffic-pacing allows the aggregate output traffic rate on any port to be set to a rate below the line rate. This feature is useful when communicating with a slow receiver or when connected to public networks with peak-rate tariffs.

Note Network clocking configuration options are applicable only to DS3 quad interfaces.

Default DS3 and E3 ATM Interface Configuration without Autoconfiguration

If ILMI has been disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all DS3 or E3 interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 8
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private

The following defaults are assigned to all DS3 port adapter interfaces:

- Framing = cbit-adm
- Cell payload scrambling = off
- Clock source = network-derived
- LBO = short
- Auto-ferf on loss of signal (LOS)= on
- Auto-ferf on out of frame (OOF)= on
- Auto-ferf on red = on
- Auto-ferf on loss of cell delineation (LCD)= on
- Auto-ferf on alarm indication signal (AIS)= on

The following defaults are assigned to all E3 port adapter interfaces:

- Framing = g.832 adm
- Cell payload scrambling = on
- Clock source = network-derived

- Auto-ferf on LOS = on
- Auto-ferf on OOF = on
- Auto-ferf on LCD = on (applicable to nonplcp mode only)
- Auto-ferf on AIS = on

Manual DS3 and E3 Interface Configuration

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **network-clock-select** *priority* **atm** *card/subcard/port*	Configures the network-derived clock.
Step 2	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 3	Switch(config-if)# **atm uni** [**side** {**private** | **public**} **type** {**network** | **user**} **version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 4	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 5	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 6	Switch(config-if)# **framing** {**cbitadm** | **cbitplcp** | **m23adm** | **m23plcp**}	Modifies the framing mode.
Step 7	Switch(config-if)# **scrambling** {**cell-payload** | **sts-stream**}	Modifies the scrambling mode.
Step 8	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 9	Switch(config-if)# **lbo** {**long** | **short**}	Modifies the line build-out.
Step 10	Switch(config-if)# **auto-ferf** {**ais** | **lcd** | **los** | **oof** | **red**}	Modifies the auto-ferf configuration.

Examples

The following example shows how to change the default ATM interface type to **private** using the **atm uni type private** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm uni type private
```

The following example shows how to change the clock source using the **clock source network-derived** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# clock source network-derived
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Configuring T1/E1 Trunk Interfaces

The T1 and E1 trunk port adapters, used for intercampus or wide-area links, have four ports.

T1/E1 Trunk Interface Configuration

The ATM switch router supports any combination of port adapters. You can configure your switch router with only the number and type of interfaces required, with up to 64 T1 or E1 interface ports on the Catalyst 8540 MSR and up to 32 T1 or E1 interface ports on the Catalyst 8510 MSR and LightStream 1010 ATM switch routers.

The port adapter supports SC-type and BNC connectors while receive and transmit LEDs on each port give quick, visual indications of port status and operation.

Traffic-pacing allows the aggregate output traffic rate on any port to be set to a rate below the line rates. This feature is useful when communicating with a slow receiver or when connected to public networks with peak-rate tariffs.

Default T1 and E1 ATM Interface Configuration without Autoconfiguration

If ILMI is disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all T1 and E1 interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VPI bits = 8
- Maximum VCI bits = 14
- ATM interface side = network
- ATM UNI type = private

The following port adapter types have specific defaults assigned.

T1 port adapter:

- Framing = ESF
- Line coding = B8ZS
- Cell payload scrambling = off
- Clock source = network-derived
- LBO = 0 to 110 feet
- Auto-ferf on loss of signal (LOS) = on
- Auto-ferf on out of frame (OOF) = on
- Auto-ferf on red = on
- Auto-ferf on loss of cell delineation (LCD) = on
- Auto-ferf on alarm indication signal (AIS) = on

E1 port adapter:

- Framing = g.832 adm
- Line coding = HDB3
- Cell payload scrambling = off
- Clock source = network-derived
- Auto-ferf on LOS = on
- Auto-ferf on OOF = on
- Auto-ferf on red = on
- Auto-ferf on LCD = on
- Auto-ferf on AIS = on

Manual T1 and E1 Interface Configuration

To manually change any of the default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **network-clock-select** *priority* **atm** *card*/*subcard*/*port*	Configures the network-derived clock.
Step 2	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 3	Switch(config-if)# **atm uni** [**side** {**private** | **public**}] [**type** {**network** | **user**}] [**version** {**3.0** | **3.1** | **4.0**}]	Modifies the ATM interface side, type, or version.
Step 4	Switch(config-if)# **atm maxvpi-bits** *max-vpi-bits*	Modifies the maximum VPI bits configuration.
Step 5	Switch(config-if)# **atm maxvci-bits** *max-vci-bits*	Modifies the maximum VCI bits configuration.
Step 6	Switch(config-if)# **framing** {**esfadm** | **esfplcp** | **sfadm** | **sfplcp**} Switch(config-if)# **framing** {**crc4adm** | **crc4plcp** | **pcm30adm pcm30plcp**}	Modifies the T1 framing mode. Modifies the E1 framing mode.
Step 7	Switch(config-if)# **linecode** {**ami** | **b8zs**} Switch(config-if)# **linecode** {**ami** | **hdb3**}	Modifies the T1 line coding. Modifies the E1 line coding.
Step 8	Switch(config-if)# **scrambling** {**cell-payload** | **sts-stream**}	Modifies the scrambling mode.
Step 9	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Modifies the clock source.
Step 10	Switch(config-if)# **lbo** {**0_110** | **110_220** | **220_330** | **330_440** | **440_550** | **550_600** | **gt_600**}	Modifies the line build-out.
Step 11	Switch(config-if)# **auto-ferf** {**ais** | **lcd** | **los** | **oof** | **red**}	Modifies the auto-ferf configuration.

Examples

The following example shows how to change the default ATM interface type to **private** using the **atm uni type private** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm uni type private
```

The following example shows how to change the clock source using the **clock source network-derived** command:

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# clock source network-derived
```

See Troubleshooting the Interface Configuration, page 18-17 to confirm your interface configuration.

Troubleshooting the Interface Configuration

Table 18-1 describes commands that you can use to confirm that the hardware, software, and interfaces for the ATM switch router are configured as intended:

Table 18-1 Configuration Testing Commands

Command	Purpose
show version	Confirms the correct version and type of software installed.
show hardware	Confirms the type of hardware installed in the system.
show interfaces	Confirms the type of hardware installed in the system.
show atm addresses	Confirms the correct configuration of the ATM address.
ping atm	Tests for connectivity between the switch and a host.
show {**atm** | **ces**} **interface**	Confirms the correct configuration of the ATM interfaces.
show atm status	Confirms the status of the ATM interfaces.
show atm vc	Confirms the status of ATM virtual interfaces.
show running-config	Confirms the correct configuration.
show startup-config	Confirms the correct configuration saved in NVRAM.
show controllers {**atm** | **ethernet**}	Confirms interface controller memory addressing.

CHAPTER 19

Configuring Circuit Emulation Services

This chapter describes circuit emulation services (CES) and how to configure the CES T1/E1 port adapters in the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. You can use CES T1/E1 port adapters for links that require constant bit rate (CBR) services.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For an overview of CES applications and operation, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For hardware installation and cabling instructions, refer to the *ATM and Layer 3 Port Adapter and Interface Module Installation Guide*.

This chapter includes the following sections:

Overview of CES T1/E1 Interfaces

You can use CES T1/E1 port adapters for links that require CBR services, such as interconnecting PBXs, time-division multiplexers (TDMs), and video conference equipment over campus, public, or private networks.

This section provides an overview of the hardware features and functions supported on the CES T1/E1 port adapters.

Clocking Options

You can configure each interface on the port adapter to support the following clocking options:

- Self-timing based on a stratum 4 level clock
- Loop timing from the received data stream—ideal for public network connections
- Timing synchronized to a selected master clock port—required to distribute a single clock across a network

Interfaces Supported

The number of CES T1/E1 interfaces you can configure is platform dependent:

- Catalyst 8540 MSR—up to 64 CES T1/E1 interfaces
- Catalyst 8510 MSR and LightStream 1010—up to 32 CES T1/E1 interfaces

Connectors Supported

The CES T1 port adapters support UTP connectors and the CES E1 port adapters support UTP, foil twisted-pair, or 75-ohm BNC connectors. Status and carrier-detect LEDs on each port give quick, visual indications of port status and operation. For detailed network management support, comprehensive statistics gathering and alarm monitoring capabilities are provided.

Functions Supported by CES Modules

The functions supported by a CES module include the following:

- Circuit emulation services interworking function (CES-IWF), which enables communication between CBR and ATM UNI interfaces
- T1/E1 CES unstructured services
- T1/E1 CES structured services

Note The Cisco IOS release 12.1(22)EB and later releases for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch router support the ATM Forum CES IWF MIB and SNMP agent code. All the MIB objects described in the ATM Forum CES Interoperability Specification, Version 2.0, are supported except the following objects:
• atmfCESBufMaxSize
• atmfCESCellLossIntegrationPeriod

• atmfCESLostCells
• atmfCESMisinsertedCellsz
• atmfCESRetryLimit
• atmfCESLocalAddr (not writeable)

Framing Formats and Line Coding Options for CES Modules

The CES modules support the framing formats and line coding options shown in Table 19-1.

Table 19-1 CES Module Framing and Line Coding Options

Module	Framing Options and Description	Line Coding Options
CES T1 port adapter	• Super Frame (SF) • Extended Super Frame (ESF)	ami or b8zs (b8zs is the default)
CES E1 port adapter (120-ohm) and CES E1 port adapter (BNC)	• E1 CRC multiframe (e1_crc_mf_lt). Configures the line type to e1_crc_mf, without channel associated signalling (CAS) enabled. • E1 CRC multiframe (e1_crc_mfCAS_lt). Configures the line type to e1_crc_mf, with CAS enabled. • E1 (e1_lt). Configures the line type to e1_lt. • E1 multiframe (e1_mfCAS_lt). Configures the line type to e1_mf, with CAS enabled.	ami or hdb3 (hdb3 is the default)

Default CES T1/E1 Interface Configuration

The following defaults are assigned to all CES T1/E1 interfaces:

- Loopback = no loopback
- Signalling mode = no signalling
- Transmit clock source = network-derived
- Data format = clear channel
- Line build-out (LBO) = 0 to 110 feet
- Cell delay variation = 2000 microseconds
- Channel associated signalling (CAS) = FALSE
- Partial fill = 47
- AAL1 service type = unstructured
- AAL1 clock mode = synchronous

The following defaults are assigned to CES T1 port adapters:

- Framing = ESF
- Line coding = B8ZS

The following defaults are assigned to CES E1 port adapters:

- Framing = E1_LT
- Line coding = HDB3
- International bits = 0x3
- National bits = 0x1f
- Multiframe spare bits = 0xb

Configuring CES T1/E1 Interfaces

To manually change any of the CES T1/E1 default configuration values, enter the **interface cbr** global configuration command to specify a CBR interface, as follows:

interface cbr *card***/***subcard***/***port*

To configure the CES T1/E1 interfaces perform the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card***/***subcard***/***port* Switch(config-if)#	Selects the physical interface to be configured and enters global configuration mode.
Step 2	Switch(config-if)# **shutdown**	Disables the interface.
Step 3	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the service type. The default is **unstructured**.
Step 4	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures the type of clocking. **Note** For structured CES, the default is **synchronous**.
Step 5	Switch(config-if)# **ces circuit** *circuit-id* [**cas**] [**cdv** *max-req*] [**circuit-name** *name*] [**partial-fill** *number*] [**shutdown**] [**timeslots** *number*] [**on-hook-detect** *pattern*]	Configures the following CES connection attributes for the circuit: • Circuit id number. – For unstructured service, use 0. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. • Enables channel-associated signalling for structured service only. The default is no cas. • Enables the peak-to-peak cell delay variation requirement. The default is 2000 milliseconds.

	Command	Purpose
		• Sets the ASCII name for the CES-IWF circuit. The maximum length is 64 characters. The default is CBRx/x/x:0. • Enables the partial AAL1 cell fill service for structured service only. The default is 47. • Disables the circuit. The default is no shutdown. • Configures the time slots for the circuit for structured service only. • Configures on-hook detection.
Step 6	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the clock source. The default is **network-derived**.
Step 7	Switch(config-if)# **ces dsx1 framing** {**sf** | **esf**}	Configures CES T1 framing mode. The default is **esf**.
	Switch(config-if)# **ces dsx1 framing** {**e1_crc_mfCAS_lt** | **e1_crc_mf_lt** | **e1_lt** | **e1_mfCAS_lt**}	Configures CES E1 framing mode. The default is **e1_lt**.
Step 8	Switch(config-if)# **ces dsx1 lbo** {**0_110** | **110_220** | **220_330** | **330_440** | **440_550** | **550_660** | **660_above** | **square_pulse**}	Configures the line build-out. The default is **0_110**.
Step 9	Switch(config-if)# **ces dsx1 linecode** {**ami** | **b8zs**}	Configures CES T1 line code type. The default is **b8zs**.
	Switch(config-if)# **ces dsx1 linecode** {**ami** | **hdb3**}	Configures CES E1 line code type. The default is **hdb3**.
Step 10	Switch(config-if)# **ces dsx1 loopback** {**line** | **noloop** | **payload**}	Configures the loopback test method. The default is **noloop**.
Step 11	Switch(config-if)# **ces dsx1 signalmode robbedbit**	Configures the CES T1 signal mode to robbedbit. The default is **no**.
Step 12	Switch(config-if)# **ces pvc** *circuit-id* **interface atm** *card***/***subcard***/***port* [**vpi** *vpi*] **vci** *vci*	Configures the destination port for the circuit and configures a hard PVC, as follows: • Specifies the circuit identification. – For unstructured service, use 0. – For T1 structured service, use 1 through 24. – For E1 structured service, use 1 through 31. • Specifies the card/subcard/port number of the ATM interface. • Specifies the virtual path identifier of the destination PVC. • Specifies the virtual channel identifier of the destination PVC.

	Command	Purpose
	Switch(config-if)# **ces pvc** *circuit-id* **dest-address** *atm-address* [[**vpi** *vpi*] **vci** *vci*] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]] [**follow-ifstate**]	Configures the destination (active) port for the circuit and configures a soft PVC, as follows: • Specifies the circuit identification. – For unstructured service, use 0. – For T1 structured service, use 1 through 24. – For E1 structured service, use 1 through 31. • Specifies the destination address of the soft PVC. • Specifies the virtual path identifier of the destination PVC. • Specifies the virtual channel identifier of the destination PVC. • Configures retry interval timers for a soft PVC, as follows: – Specifies in milliseconds, the retry interval after the first failed attempt. The default is 5,000. – Specifies in seconds, the maximum retry interval between any two attempts. The default is 600. • Configures the source (active) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 13	Switch(config-if)# **ces pvc** *circuit-id* **follow-ifstate**	Configures the destination (passive) port circuit status for a soft-PVC to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 14	Switch(config-if)# **no shutdown**	Reenables the interface.

Examples

The following example shows how to change the default cell delay variation for circuit 0 to 30,000, using the **ces circuit** command:

```
Switch# configure terminal
Switch(config)# interface cbr 3/0/0
Switch(config-if)# shutdown
Switch(config-if)# ces circuit 0 cdv 3000
Switch(config-if)# no shutdown
```

Note You must use the **shutdown** command to shut down the interface before you can modify the circuit. After modifying the circuit, use the **no shutdown** command to reenable the interface.

The following example shows how to change the default CBR interface framing mode to super frame, using the **ces dsx1 framing** command:

```
Switch# configure terminal
Switch(config)# interface cbr 3/0/0
Switch(config-if)# ces dsx1 framing sf
```

The following example shows how to change the default CBR interface line build-out length to range from 330 to 440 feet, using the **ces dsx1 lbo** command:

```
Switch# configure terminal
Switch(config)# interface cbr 3/0/0
Switch(config-if)# ces dsx1 lbo 330_440
```

The following example shows how to change the default CBR interface line code method to binary 8 zero suppression, using the **ces dsx1 linecode** command:

```
Switch# configure terminal
Switch(config)# interface cbr 3/0/0
Switch(config-if)# ces dsx1 linecode b8zs
```

The following example shows how to change the default CBR interface loopback method to payload, using the **ces dsx1 loopback** command:

```
Switch# configure terminal
Switch(config)# interface cbr 3/0/0
Switch(config-if)# ces dsx1 loopback payload
```

See Chapter 18, "Configuring Interfaces," to confirm your interface configuration.

General Guidelines for Creating Soft PVCs for Circuit Emulation Services

You can create either hard permanent virtual channels (PVCs) or soft PVCs for unstructured or structured CES, depending on your particular CES application requirements. The main difference between hard and soft PVCs is rerouting in case of failure, as follows:

- A hard PVC on a CES T1/E1 port—Should a failure occur in a midpoint switch, hard PVCs are not automatically rerouted.
- A soft PVC on a CES T1/E1 port—Should a failure occur in a midpoint switch, soft PVCs are rerouted automatically, assuming another route is available.

This section provides general guidelines for configuring soft PVCs for CES modules. For specific instructions for configuring both hard and soft PVCs, see the following sections:

- Configuring T1/E1 Unstructured Circuit Emulation Services, page 19-9
- Configuring T1/E1 Structured (n x 64) Circuit Emulation Services, page 19-18

Note The steps in these guidelines assume that you have already used the **ces circuit** commands to configure circuits on the CES interfaces. If you have not yet configured circuits on the CES interfaces, the **show ces address** command will not display any addresses. For simplicity, the steps in these guidelines describe how to create a soft PVC between interface modules in the same ATM switch router.

To configure soft PVCs for either unstructured or structured circuit emulation services, follow these steps:

Step 1 Determine which CES interfaces are currently configured in your ATM switch router chassis, using the **show ces status** command in privileged EXEC mode.

```
CESwitch# show ces status
   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR3/0/0       UP        UP          T1
     CBR3/0/1     DOWN        UP          T1
     CBR3/0/2     DOWN        UP          T1
     CBR3/0/3       UP        UP          T1
```

Step 2 Determine which two ports you want to define as participants in the soft PVC.

Step 3 Decide which of the two ports you want to designate as the destination (or passive) side of the soft PVC.

Note This is an arbitrary decision—you can choose either port as the destination end of the circuit. However, you must decide which port is to function in this capacity and proceed accordingly.

Step 4 Decide whether you want the state of the soft PVC to match the state of the ports.

Step 5 Configure the destination (passive) side of the soft PVC. You must configure the destination end of the soft PVC first, as this end defines a CES-IWF ATM address for that circuit.

Note If the interface is up, you might have to disable it, using the **shutdown** command, before you can configure the circuit. After configuring the circuit, use the **no shutdown** command to reenable the interface.

```
CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/1
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces circuit 0 circuit-name CBR-PVC-B
CESwitch(config-if)# no shutdown
```

Step 6 Retrieve the CES-IWF ATM address of the soft PVC's destination end, using the **show ces address** command. The following example shows how to display the CES-IWF ATM address and VPI/VCI for a CES circuit:

```
CESwitch# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1030.10  CBR-PVC-A vpi 0 vci 16
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1030.20  CBR-PVC-AC vpi 0 vci 1056
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10  CBR-PVC-B vpi 0 vci 1040
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1038.10  CBR-PVC-CA vp1 0 vci 3088
```

Step 7 Configure the source (active) end of the soft PVC last, using the information derived from Step 6. You must configure the source end of the soft PVC last, because that end not only defines the configuration information for the source port, but also requires you to enter the CES-IWF ATM address and VPI/VCI values for the destination circuit.

Note If the interface is up, you might have to disable it, using the **shutdown** command, before you can configure the circuit. After configuring the circuit, use the **no shutdown** command to reenable the interface.

```
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces circuit 0
CESwitch(config-if)# ces pvc 0 dest-address 47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10 vpi 0 vci 104
CESwitch(config-if)# no shutdown
```

Step 8 To verify that the CES circuits are up on both sides (source and destination), run the **show ces interface** command. To verify that the soft PVC was established between two switches, run the **show atm vc interface** command.

Configuring T1/E1 Unstructured Circuit Emulation Services

This section provides an overview of unstructured (clear channel) circuit emulation services and describes how to configure CES modules for unstructured circuit emulation services.

Overview of Unstructured Circuit Emulation Services

Unstructured circuit emulation services in an ATM switch router network emulate point-to-point connections over T1/E1 leased lines. This service maps the entire bandwidth necessary for a T1/E1 leased line connection across the ATM network, allowing users to interconnect PBXs, TDMs, and video conferencing equipment.

For a detailed description of unstructured circuit emulation services, refer to the *Guide to ATM Technology*.

The circuit you set up on a CBR port for unstructured service is always identified as circuit 0, because you can establish only one unstructured circuit on any given CBR port. An unstructured circuit uses the entire bandwidth of a T1 port (1.544 Mbps) or an E1 port (2.048 Mbps).

The following subsections describe the procedures for configuring CES modules for unstructured circuit emulation services:

- Configuring a Hard PVC for Unstructured CES, page 19-10
- Verifying a Hard PVC for Unstructured CES, page 19-13
- Configuring a Soft PVC for Unstructured CES, page 19-13
- Verifying a Soft PVC for Unstructured CES, page 19-17

Configuring Network Clocking for Unstructured CES

Circuit emulation services require that the network clock be configured properly. Unstructured services can use synchronous, Synchronous Residual Time Stamp (SRTS), or adaptive clocking mode. For instructions on configuring network clocking, see Chapter 3, "Initially Configuring the ATM Switch Router." For a discussion of clocking issues and network examples, refer to the network clock synchronization and network clocking for CES topics in the *Guide to ATM Technology*.

Configuring Synchronous Clocking With an OC-12c Interface Module

When synchronous clocking is being used and propagated via an OC-12c interface module, be sure to use the following configurations:

- For the Catalyst 8540 MSR, use the optional clocking module.
- For the Catalyst 8510 MSR and LightStream 1010 ATM switch routers, use feature card per flow queueing (FC-PFQ).

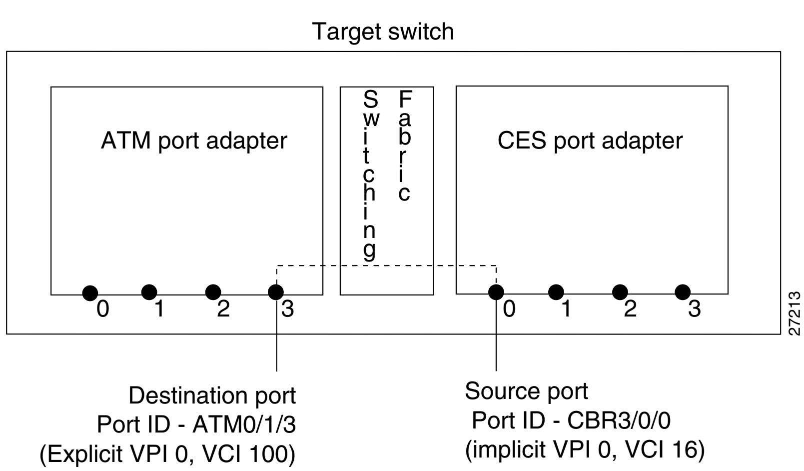
Configuring a Hard PVC for Unstructured CES

A CES module converts CBR traffic into ATM cells for propagation through an ATM network. CBR traffic arriving on a CES module port must first be segmented into ATM cells. This cell stream is then directed to an outgoing ATM or CBR port.

Note As a general rule when configuring a hard PVC, you must interconnect a CBR port and an ATM port in the same ATM switch router chassis.

Figure 19-1 displays unstructured circuit emulation services configured on an ATM switch router, using ATM and CES interface modules to create a hard PVC. In this example, the hard permanent virtual channel (PVC) also uses adaptive clocking, and this CES circuit enables bidirectional, unstructured CBR traffic to flow between these two modules.

Figure 19-1 Hard PVC Configured for Unstructured CES



To configure a hard PVC for unstructured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the source CBR port.
Step 2	Switch# **show atm status**	Displays information about the current ATM interfaces. Use this command to choose the destination ATM port. **Note** The interface must be up.
Step 3	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 4	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 5	Switch(config-if)# **shutdown**	Disables the interface.
Step 6	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 7	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures the AAL1 clock mode.
Step 8	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Switch(config-if)# **ces pvc** *circuit-id* **interface atm** *card/subcard/port* **vpi** *vpi* **vci** *vci*	Configures the hard PVC to the ATM interface and VPI/VCI. **Note** The VPI/VCI are arbitrary here. They are not fixed, whereas the VPI/VCI described in General Guidelines for Creating Soft PVCs for Circuit Emulation Services, page 19-7 are fixed.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the hard PVC for unstructured CES (shown in Figure 19-1):

```
CESwitch# show ces status
Interface       IF      Admin         Port  Channels in
     Name        Status   Status        Type       use
------------- -------- --------- ----------- -----------
     CBR3/0/0        UP        UP           T1
     CBR3/0/1      DOWN        UP           T1
     CBR3/0/2      DOWN        UP           T1
     CBR3/0/3        UP        UP           T1
```

```
CESwitch# show atm status
NUMBER OF INSTALLED CONNECTIONS: (P2P=Point to Point, P2MP=Point to MultiPoint,
MP2P=Multipoint to Point)

Type      PVCs SoftPVCs      SVCs      TVCs      PVPs SoftPVPs      SVPs       Total
P2P         27        2        13         0         0        0         0          42
P2MP         0        0         2         0         0        0         0           2
MP2P         0        0         0         0         0        0         0           0
                                        TOTAL INSTALLED CONNECTIONS =          44

PER-INTERFACE STATUS SUMMARY AT 18:12:45 UTC Thu Jul 22 1999:
   Interface       IF         Admin  Auto-Cfg    ILMI Addr     SSCOP    Hello
     Name        Status       Status    Status    Reg State     State    State
------------- -------- ------------ -------- ------------ --------- --------
ATM0/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM0/0/5          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/6          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/7          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/ima1         UP           up     done  UpAndNormal    Active 2way_in
ATM0/1/0          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/1          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/2          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/3          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/7          DOWN         down  waiting          n/a      Idle      n/a
ATM0/1/ima2         UP           up     done  UpAndNormal    Active 2way_in
ATM1/0/0          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/3            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/0            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM2/0/0            UP           up      n/a  UpAndNormal      Idle      n/a
ATM-P3/0/3          UP           up  waiting          n/a      Idle      n/a
ATM3/1/0          DOWN         down  waiting          n/a      Idle      n/a
ATM3/1/1            UP           up     done  UpAndNormal    Active 2way_in
ATM3/1/1.99         UP           up     done  UpAndNormal    Active 2way_in
ATM3/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM3/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM-P4/0/0          UP           up  waiting          n/a      Idle      n/a

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service unstructured
CESwitch(config-if)# ces aal1 clock adaptive
CESwitch(config-if)# ces circuit 0 circuit-name CBR-PVC-A
CESwitch(config-if)# ces pvc 0 interface atm 0/1/3 vpi 0 vci 100
CESwitch(config-if)# no shutdown
```

Verifying a Hard PVC for Unstructured CES

To verify the hard PVC configuration, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows configuration information for the hard PVC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows detailed interface configuration information for the hard PVC.

Examples

The following example shows how to display the basic information about the hard PVC shown in Figure 19-1, using the **show ces circuit** command:

```
CESwitch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0    0       HardPVC           ATM0/1/3      0       100  UP
```

The output from this command verifies the source (CBR 3/0/0) and destination (ATM 0/1/3) port IDs of the hard PVC and indicates that the circuit is up.

The following example shows how to display detailed information about the hard PVC shown in Figure 19-1, using the **show ces circuit interface** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 0
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 0, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_ADAPT
Channel in use on this port: 1-24
Channels used by this circuit: 1-24
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow 903952, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      827, startDequeueDepth      437
Partial Fill:       47, Structured Data Transfer 0
HardPVC
src: CBR3/0/0 vpi 0, vci 16
Dst: ATM0/1/3 vpi 0, vci 100
```

The output from this command verifies the following configuration information:

- The circuit named CBR-PVC-A is in an UP state.
- The interface CBR 3/0/0 has a circuit id of 0 (because the entire bandwidth of the port is dedicated to that circuit).
- The AAL1 clocking method is adaptive clocking.
- The source port for the hard PVC is CBR 3/0/0. The destination port is ATM 0/1/3.

Configuring a Soft PVC for Unstructured CES

In a soft PVC, as well as a hard PVC, you configure both ends of the CES circuit. However, a soft PVC typically involves CES modules at opposite edges of an ATM network, so a soft PVC can be set up between any two CES modules anywhere in your network.

The destination address of a soft PVC can point to either of the following:

- Any ATM switch router external ATM port in the network
- A port in any other CES module in the network

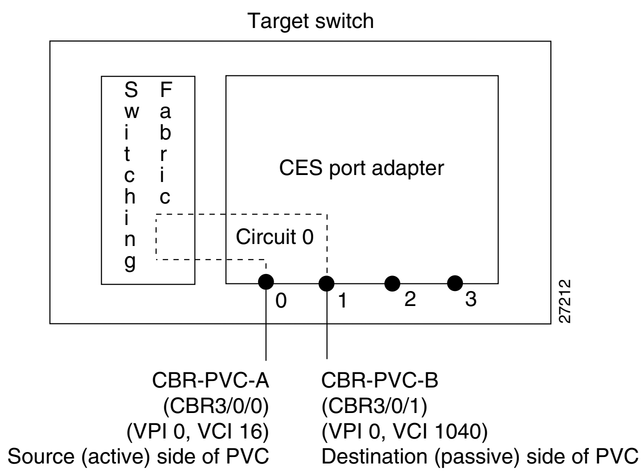
For example, to set up a soft PVC involving a local node and a destination node at the opposite edge of the network, you need to determine the CES-IWF ATM address of the port in the destination node to complete soft PVC setup.

To obtain the destination address (dest-address) for a port already configured in a CES port adapter, log into the remote ATM switch router containing that module. Then use the **show ces address** command to display all the CES-IWF ATM addresses currently configured for that node.

Figure 19-2 displays a soft PVC configured for unstructured CES. The soft PVC uses adaptive clocking and the source clock is network-derived.

Note Typically you will configure a soft PVC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a soft PVC between modules in the same ATM switch router chassis.

Figure 19-2 Soft PVC Configured for Unstructured CES



Configuring a soft PVC for unstructured CES is a two-phase process:

- Phase 1—Configuring the Destination (Passive) Side of the Soft PVC, page 19-15
- Phase 2—Configuring the Source (Active) Side of the Soft PVC, page 19-16

Phase 1—Configuring the Destination (Passive) Side of the Soft PVC

To configure the destination (passive) side of a soft PVC destination port, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about current CBR interfaces. Use this command to choose the destination port.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card***/***subcard***/***port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 6	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures the CES interface AAL1 clock mode.
Step 7	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Switch(config-if)# **ces pvc** *circuit-id* **passive follow-ifstate**	Configures the destination (passive) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the destination (passive) side of a soft PVC, as shown in Figure 19-2:

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR3/0/0       UP        UP           T1
     CBR3/0/1       UP        UP           T1
     CBR3/0/2       UP        UP           T1
     CBR3/0/3       UP        UP           T1

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/1
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service unstructured
CESwitch(config-if)# ces aal1 clock synchronous
```

```
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces circuit 0 circuit-name CBR-PVC-B
CESwitch(config-if)# no shutdown
```

Note If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR3/0/1:0.

Phase 2—Configuring the Source (Active) Side of the Soft PVC

To configure the source (active) side of a soft PVC destination port, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces address**	Shows the CES address and VPI/VCI for the destination end of the circuit. Use this command to retrieve the destination's VPI/VCI.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card***/***subcard***/***port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 6	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures the CES interface AAL1 clock mode.
Step 7	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Switch(config-if)# **ces pvc** *circuit-id* **dest-address** *remote_atm_address* **vpi** *vpi* **vci** *vci* [**follow-ifstate**]	Configures the soft PVC to the destination CES-IWF ATM addresses and VPI/VCI of the circuit. **Note** Use the destination's VPI/VCI, which you retrieved in Step 1. The **follow-ifstate** keyword configures the source (active) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the source (active) side of a soft PVC, as shown in Figure 19-2:

```
CESwitch# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10 CBR-PVC-B

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service unstructured
CESwitch(config-if)# ces aal1 clock synchronous
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces circuit 0 circuit-name CBR-PVC-A
CESwitch(config-if)# ces pvc 0 dest-address 47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10 vpi 0 vci 1040
CESwitch(config-if)# no shutdown
```

Verifying a Soft PVC for Unstructured CES

To verify the soft PVC configuration, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows the soft PVC configuration information.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed soft PVC interface configuration information.

Examples

The following example shows how to display the soft PVC configured in the previous section (shown in Figure 19-2), using the **show ces circuit** command:

```
CESwitch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0     0       Active SoftVC   ATM-P3/0/3      0        16 UP
 CBR3/0/1     0       Passive SoftVC  ATM-P3/0/3      0      1040 UP
```

The following example shows how to display the detailed circuit information for CBR 3/0/1, the destination (passive) side of the soft PVC (shown in Figure 19-2), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/1 0
Circuit: Name CBR-PVC-B, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/1, Circuit_id 0, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-24
Channels used by this circuit: 1-24
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0xC100 (vci = 3088)
Configured CDV 2000 usecs, Measured CDV 2378 usecs
De-jitter: UnderFlow 137, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 0
Passive SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10 vpi 0, vci 1040
```

```
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.00
```

The following example shows how to display the detailed circuit information for CBR 3/0/0, the source (active) side of the soft PVC (shown in Figure 19-2), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 0
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 0, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-24
Channels used by this circuit: 1-24
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV 326 usecs
De-jitter: UnderFlow 1, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 0
Active SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.10 vpi 0, vci 16
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10
```

Configuring T1/E1 Structured (*n* x 64) Circuit Emulation Services

This section provides an overview of structured (*n* x 64 Kbps) circuit emulation services and describes how to configure CES modules for structured circuit emulation services.

Overview of Structured Circuit Emulation Services

An important distinction between structured and unstructured circuit emulation services is that structured circuit emulation services allow you to allocate T1/E1 bandwidth. Structured circuit emulation services only use the T1/E1 bandwidth actually required to support the active structured circuit(s) you configure.

For example, configuring a CES module for structured services allows you to define multiple hard PVCs or soft PVCs for any CES T1 or E1 port. In both module types, any bits not available for structured circuit emulation services are used for framing and out-of-band control.

n x 64 refers to a circuit bandwidth (data transmission speed) provided by the aggregation of *n* x 64-Kbps channels, where *n* is an integer greater than or equal to 1. The 64-Kbps data rate, or the DS0 channel, is the basic building block of the T carrier systems (T1, T2, and T3).

The T1/E1 structured (*n* x 64) circuit emulation services enable a CES module to function in the same way as a classic Digital Access and Crossconnect System (DACS) switch.

The Simple Gateway Control Protocol (SGCP) provides similar functionality by controlling structured CES circuits for voice over ATM. For additional information see Configuring SGCP, page 19-56.

For a detailed description of structured circuit emulation services, refer to the *Guide to ATM Technology*.

Configuring Network Clocking for Structured CES

Circuit emulation services require that the network clock be configured properly. For structured services, synchronous clocking is required. For instructions on configuring network clocking, see Chapter 3, "Initially Configuring the ATM Switch Router.". For a discussion of clocking issues and network examples, refer to the network clock synchronization and network clocking for CES topics in the *Guide to ATM Technology*.

Configuring Synchronous Clocking With an OC-12c Interface Module

When synchronous clocking is being used and propagated via an OC-12c interface module, be sure to use the following configurations:

- For the Catalyst 8540 MSR, use the optional clocking module.
- For the Catalyst 8510 MSR and LightStream 1010 ATM switch routers, use feature card per flow queueing (FC-PFQ).

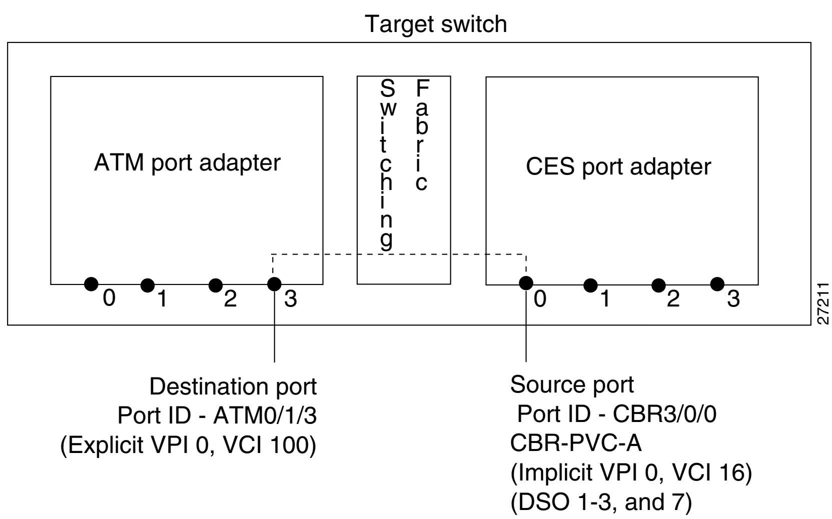
Configuring a Hard PVC for Structured CES

This section describes how to configure a hard permanent virtual channel (PVC) for structured circuit emulation services.

Figure 19-3 shows that the hard PVC for structured CES connection is configured with the following parameters:

- Four time slots (DS0 channels 1 to 3, and 7) are configured for a circuit named CBR-PVC-A.
- ATM port 0/1/3 in the ATM switch router is designated as the destination port of the hard PVC.
- The CES AAL1 service is structured and the clock source is network-derived.
- The framing is esf and the line code is b8zs.

Figure 19-3 Hard PVC Configured for Structured CES



To configure the CES port for structured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about current CBR interfaces. Use this command to choose the source port.
Step 2	Switch# **show atm status**	Displays information about current ATM interfaces. Use this command to choose the destination port.
Step 3	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 4	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 5	Switch(config-if)# **shut**	Shuts down the interface.
Step 6	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 7	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Switch(config-if)# **ces dsx1 framing** {**sf** | **esf**} Switch(config-if)# **ces dsx1 framing** {**e1_crc_mfCAS_lt** | **e1_crc_mf_lt** | **e1_lt** | **e1_mfCAS_lt**}	Configures the CES T1 framing type. The default is **esf**. Configures the CES E1 framing type. For CES E1, the default is **e1_lt**.

Example

The following example shows how to configure the hard PVC for structured T1 CES, as shown in Figure 19-3:

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR3/0/0       UP        UP          T1
     CBR3/0/1       UP        UP          T1
     CBR3/0/2       UP        UP          T1
     CBR3/0/3       UP        UP          T1

CESwitch# show atm status

NUMBER OF INSTALLED CONNECTIONS: (P2P=Point to Point, P2MP=Point to MultiPoint,
MP2P=Multipoint to Point)

Type      PVCs  SoftPVCs      SVCs      TVCs      PVPs  SoftPVPs      SVPs       Total
P2P         27         2        13         0         0         0         0          42
P2MP         0         0         2         0         0         0         0           2
MP2P         0         0         0         0         0         0         0           0
                                      TOTAL INSTALLED CONNECTIONS =          44

PER-INTERFACE STATUS SUMMARY AT 18:12:45 UTC Thu Jul 22 1999:
   Interface      IF         Admin  Auto-Cfg     ILMI Addr     SSCOP    Hello
```

```
     Name       Status      Status    Status    Reg State     State    State
------------- -------- ------------ -------- ------------ --------- --------
ATM0/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM0/0/5          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/6          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/7          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/0          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/1          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/2          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/3            UP           up     done  UpAndNormal    Active      n/a
ATM0/1/7          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/0          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/3            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/0            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM2/0/0            UP           up      n/a  UpAndNormal      Idle      n/a
ATM-P3/0/3          UP           up  waiting          n/a      Idle      n/a
ATM3/1/0          DOWN         down  waiting          n/a      Idle      n/a
ATM3/1/1            UP           up     done  UpAndNormal    Active 2way_in
ATM3/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM3/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM-P4/0/0          UP           up  waiting          n/a      Idle      n/a

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service structured
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces dsx1 framing esf
CESwitch(config-if)# ces dsx1 linecode b8zs
CESwitch(config-if)# ces circuit 1 timeslots 1-3,7
CESwitch(config-if)# ces circuit 1 circuit-name CBR-PVC-A
CESwitch(config-if)# ces pvc 1 interface atm 0/1/3 vpi 0 vci 100
CESwitch(config-if)# no shutdown
```

Note If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR3/0/0:1. For structured CES, the circuit number sequence always begins at 1 for each port in a CES module.

The virtual path identifier/virtual channel identifier (VPI/VCI) values shown in the example (vpi 0 vci 100) are for demonstration purposes only. The service provider you select gives you a virtual path for your data, but you must decide which VCI number to assign to the circuit.

Verifying a Hard PVC for Structured CES

To verify the hard PVC configured with structured services, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows the configuration information for the hard PVC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed interface configuration information for the hard PVC.

Examples

The following example shows the details of the hard PVC, shown in Figure 19-3, using the **show ces circuit** command:

```
CESwitch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0    1       HardPVC           ATM0/1/3      0       100 UP
```

The output from this command verifies the source (CBR 3/0/0) and destination (ATM 0/1/3) port IDs of the hard PVC and indicates that the circuit is up.

The following example shows the interface details for port CBR 3/0/0 (shown in Figure 19-3), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 1
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-3, 7
Channels used by this circuit: 1-3, 7
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV 326 usecs
De-jitter: UnderFlow 1, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 1
HardPVC
Src: CBR3/0/0 vpi 0, vci 16
Dst: ATM0/1/3 vpi 0, vci 100
```

The output from this command verifies the following configuration information:

- The circuit named CBR-PVC-A is in an UP state.
- The interface CBR 3/0/0 has a circuit id of 1 (because structured CES services always begin at 1 for each port in a CES module).
- The channels being used by this circuit are 1-3 and 7.
- The source port for the hard PVC is CBR 3/0/0. The destination port is ATM 0/1/3.

Configuring a Hard PVC for Structured CES with a Shaped VP Tunnel

A shaped VP tunnel is a VP tunnel that, by default, carries only VCs of the constant bit rate (CBR) service category with a peak cell rate (PCR). However, it is possible to configure a shaped virtual path (VP) tunnel to carry VCs of other service categories. The overall output of the shaped VP tunnel is rate-limited, by hardware, to the PCR of the tunnel.

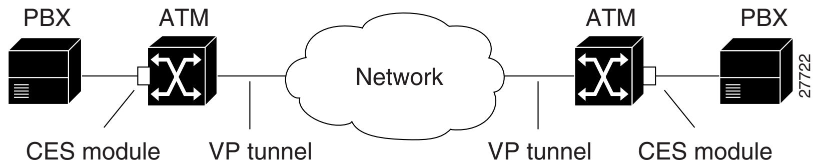
This section describes how to configure a hard PVC for structured CES with a shaped VP tunnel, which is a two-phase process, as follows:

- Phase 1—Configuring a Shaped VP Tunnel, page 19-23
- Phase 2—Configuring a Hard PVC, page 19-25

For more information about configuring shaped VP tunnels, see Chapter 7, "Configuring Virtual Connections.".

Figure 19-4 shows an example of a how a structured CES circuit can be configured with a shaped VP tunnel.

Figure 19-4 Structured CES Circuit Configured with a Shaped VP Tunnel



Phase 1—Configuring a Shaped VP Tunnel

To configure a shaped VP tunnel, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 2	Switch(config)# **atm connection-traffic-table-row** [**index** *row-index*] **cbr pcr** *rate*	Configures the connection traffic table row for the desired PVP CBR cell rate.
Step 3	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.

	Command	Purpose
Step 5	Switch(config-if)# **atm pvp** *vpi* [**hierarchical** | **shaped**] [**rx-cttr** *index*] [**tx-cttr** *index*]	Configures a shaped VP tunnel, as follows: • Specifies whether the tunnel is hierarchical or shaped. **Note** To configure a shaped VP tunnel to carry PVCs of other (non-CBR) service categories, the VP tunnel must be configured as a hierarchical tunnel. • Specifies the connection traffic table row in the received direction. The default is 1. • Specifies the connection traffic table row in the transmitted direction. The default is 1.
Step 6	Switch(config-if)# **no shutdown**	Reenables the interface.
Step 7	Switch(config-if)# **interface atm** *card/subcard/port.subinterface#* Switch(config-subif)#	Configures a subinterface. **Note** You cannot create a subinterface on the route processor interface ATM 0.
Step 8	Switch(config-subif)# **exit** Switch(config)#	Exits subinterface mode.

Note Even though the shaped VP tunnel is defined as CBR, it can carry PVCs of another service category by substituting the new service category after the tunnel interface has been initially configured. For information about configuring VP tunnels with other (non-CBR) service categories, see theChapter 7, "Configuring Virtual Connections.".

Example

The following example shows how to configure a shaped VP tunnel.

```
CESwitch# configure terminal
CESwitch(config)# atm connection-traffic-table-row index 10 cbr pcr 4000
CESwitch(config)# interface atm 0/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# atm pvp 1 shaped rx-cttr 10 tx-cttr 10
CESwitch(config-if)# no shutdown
CESwitch(config-if)# interface atm 0/0/0.1
CESwitch(config-subif)# exit
CESwitch(config)#
```

Note A shaped VP tunnel is defined as a CBR VP with a PCR. A maximum of 64 shaped VP tunnels can be defined on each of the following interface groups: (0/0/*x*, 1/0/*x*), (0/1/*x*, 1/1/*x*), (2/0/*x*, 3/0/*x*), (2/1/*x*, 3/1/*x*), (9/0/*x*, 10/0/*x*), (9/1/*x*, 10/1/*x*), (11/0/*x*, 12/0/*x*) and (11/1/*x*, 12/1/*x*). For further limitations on shaped VP tunnels, see the Chapter 7, "Configuring Virtual Connections.".

Phase 2—Configuring a Hard PVC

To configure a hard PVC, follow these steps:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the source CBR port.
Step 2	Switch# **show atm status**	Displays information about the current ATM interfaces. Use this command to choose the destination ATM port. **Note** The interface must be up.
Step 3	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 4	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 5	Switch(config-if)# **shutdown**	Disables the interface.
Step 6	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 7	Switch(config-if)# **ces circuit** *circuit-id* [**timeslots** *number*]	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. **Note** The 0 circuit identifier is reserved for unstructured service. • Time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. • For CES E1, the range is 1 through 31.

	Command	Purpose
Step 8	Switch(config-if)# **ces pvc** *circuit-id* **interface atm** *card/subcard/port* **vpi** *vpi* **vci** *vci*	Configures the destination port for the circuit and configures a hard PVC, as follows: • Specifies the circuit identification. (Use the circuit id from the previous step.) • Specifies the card/subcard/port number of the ATM interface. • Specifies the VPI of the destination PVC. • Specifies the VCI of the destination PVC.
Step 9	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure hard PVCs for the shaped VP tunnel.

```
CESwitch# show ces status
Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR3/1/0       UP        UP          T1
     CBR3/1/1       UP        UP          T1
     CBR3/1/2       UP        UP          T1
     CBR3/1/3       UP        UP          T1
CESwitch# show atm status

NUMBER OF INSTALLED CONNECTIONS: (P2P=Point to Point, P2MP=Point to MultiPoint,
MP2P=Multipoint to Point)

Type     PVCs  SoftPVCs     SVCs     TVCs     PVPs  SoftPVPs     SVPs      Total
P2P        27         2       13        0        0         0        0         42
P2MP        0         0        2        0        0         0        0          2
MP2P        0         0        0        0        0         0        0          0
                                      TOTAL INSTALLED CONNECTIONS =          44

PER-INTERFACE STATUS SUMMARY AT 18:12:45 UTC Thu Jul 22 1999:
   Interface      IF         Admin  Auto-Cfg    ILMI Addr     SSCOP    Hello
     Name       Status      Status    Status    Reg State     State    State
------------- -------- ------------ -------- ------------ --------- --------
ATM0/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM0/0/5          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/6          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/7          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/0/ima1         UP           up     done  UpAndNormal    Active 2way_in
ATM0/1/0          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/1          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/2          DOWN     shutdown  waiting          n/a      Idle      n/a
ATM0/1/3            UP           up     done  UpAndNormal    Active      n/a
ATM0/1/7          DOWN         down  waiting          n/a      Idle      n/a
ATM0/1/ima2         UP           up     done  UpAndNormal    Active 2way_in
ATM1/0/0          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/0/3            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/0            UP           up     done  UpAndNormal    Active      n/a
ATM1/1/1          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/2          DOWN         down  waiting          n/a      Idle      n/a
ATM1/1/3          DOWN         down  waiting          n/a      Idle      n/a
ATM2/0/0            UP           up      n/a  UpAndNormal      Idle      n/a
ATM-P3/0/3          UP           up  waiting          n/a      Idle      n/a
```

```
ATM3/1/0          DOWN        down  waiting          n/a      Idle      n/a
ATM3/1/1            UP          up     done  UpAndNormal    Active 2way_in
ATM3/1/1.99         UP          up     done  UpAndNormal    Active 2way_in
ATM3/1/2          DOWN        down  waiting          n/a      Idle      n/a
ATM3/1/3          DOWN        down  waiting          n/a      Idle      n/a
ATM-P4/0/0          UP          up  waiting          n/a      Idle      n/a

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/1/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service structured
CESwitch(config-if)# ces circuit 1 timeslots 1
CESwitch(config-if)# ces pvc 1 interface atm 0/0/0.1 vpi 1 vci 101

CESwitch(config-if)# ces circuit 2 timeslots 2
CESwitch(config-if)# ces pvc 2 interface atm 0/0/0.1 vpi 1 vci 102

CESwitch(config-if)# ces circuit 3 timeslots 3
CESwitch(config-if)# ces pvc 3 interface atm 0/0/0.1 vpi 1 vci 103
CESwitch(config-if)# no shutdown
```

Verifying a Hard PVC for Structured CES with a Shaped VP Tunnel

To verify the hard PVC configuration, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows configuration information for the hard PVC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows detailed interface configuration information for the hard PVC.
show atm vp interface atm *card/subcard/port vpi*	Show detailed interface configuration information for the shaped VP tunnel.

Examples

The following example shows how to display the basic information about the hard PVC shown in Figure 19-3, using the **show ces circuit** command:

```
CESwitch# show ces circuit

Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/1/0    1       HardPVC         ATM0/0/0.1      1       101  DOWN
 CBR3/1/0    2       HardPVC         ATM0/0/0.1      1       102  DOWN
 CBR3/1/0    3       HardPVC         ATM0/0/0.1      1       103  DOWN
 CBR3/1/3    0       Active SoftVC      UNKNOWN      0         0  DOWN
```

The following example shows how to display detailed information about the hard PVC shown in Figure 19-3, using the **show ces circuit interface** command:

```
CESwitch# show ces circuit interface cbr 3/1/0 1
Circuit: Name CBR3/1/0:1, Circuit-state ADMIN_UP / oper-state UP Interface CBR3
Port Clocking loop-timed, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-3
Channels used by this circuit: 1
Cell-Rate: 172, Bit-Rate 64000
cas OFF, cell_header 0x100 (vci = 16)
```

```
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcLoc, maxQueueDepth       81, startDequeueDepth       64
Partial Fill:       47, Structured Data Transfer 1
HardPVC
src: CBR3/1/0 vpi 0, vci 16
Dst: ATM0/0/0 vpi 1, vci 101
```

The following example shows how to display detailed information about the shaped VP tunnel shown in Figure 19-4, using the **show atm vp** command:

```
NewLs1010# show atm vp interface atm 0/0/0 1

Interface: ATM0/0/0, Type: oc3suni
VPI = 1
Status: SHAPED TUNNEL
Time-since-last-status-change: 13:59:23
Connection-type: PVP
Cast-type: point-to-point
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Threshold Group: 1, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0,  Tx Clp1: 0
Rx Clp0:0,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx Clp0 q full drops:0, Rx Clp1 qthresh drops:0
→ Rx connection-traffic-table-index: 10
→ Rx service-category: CBR (Constant Bit Rate)
→ Rx pcr-clp01: 4000
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: none
→ Tx connection-traffic-table-index: 10
→ Tx service-category: CBR (Constant Bit Rate)
→ Tx pcr-clp01: 4000
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: none
```

Configuring a Soft PVC for Structured CES

In a soft PVC, as well as a hard PVC, you configure both ends of the CES circuit. However, a soft PVC typically involves CES modules at opposite edges of an ATM network, so a soft PVC can be set up between any two CES modules anywhere in your network.

The destination address of a soft PVC can point to either of the following:

- Any ATM switch router external ATM port in the network
- A port in any other CES module in the network

For example, to set up a soft PVC involving a local node and a destination node at the opposite edge of the network, you need to determine the CES-IWF ATM address of the port in the destination node to complete a soft PVC setup.

To obtain the destination address for an already configured port in a CES module, log into the remote ATM switch router containing that module. Then use the **show ces address** command to display all the CES-IWF ATM addresses currently configured for that node.

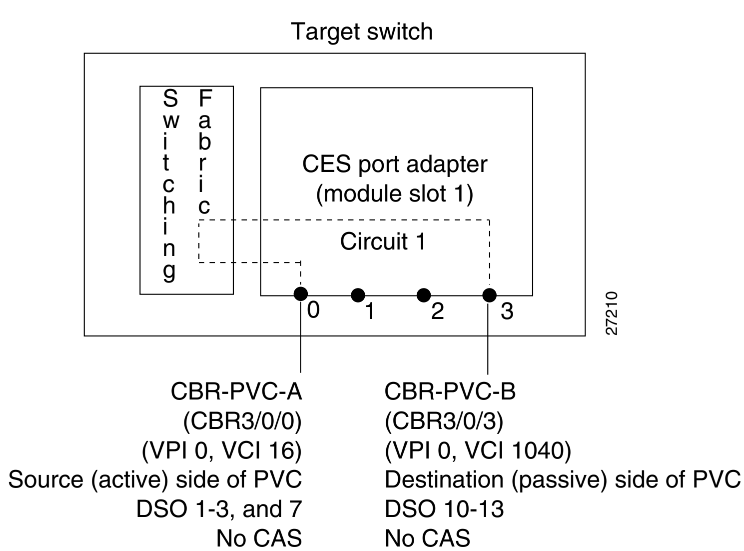
Note Typically you will configure a soft PVC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a soft PVC between modules in the same ATM switch router chassis.

This section describes how to configure a soft PVC for structured service based on the following assumptions:

- The source (active) side of the soft PVC is named CBR-PVC-A.
- The destination (passive) side of the soft PVC is named CBR-PVC-B.
- Four time slots (DS0 channels) are configured for the soft PVC, as follows:
  - For circuit CBR-PVC-A: DS0 channels 1 to 3 and 7 are used on port CBR 3/0/0.
  - For circuit CBR-PVC-B: DS0 channels 10 to 13 are used on port CBR 3/0/3.
- Channel associated signalling (CAS) is not enabled. For information about configuring a soft PVC with CAS, see Configuring a Soft PVC for Structured CES, page 19-28.
- CES AAL1 service is structured and the clock source is network-derived.
- CES framing is esf and the line code is b8zs.
- The status of the circuit will follow the status of the physical interface.

Figure 19-5 shows an example of a soft PVC configured for structured CES.

Figure 19-5 Soft PVC Configured for Structured CES



Configuring a soft PVC for structured CES is a two-phase process:

- Phase 1—Configuring the Destination (Passive) Side of a Soft PVC, page 19-30
- Phase 2—Configuring the Source (Active) Side of a Soft PVC, page 19-31

Phase 1—Configuring the Destination (Passive) Side of a Soft PVC

To configure a destination (passive) side of a soft PVC for structured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the destination port.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 6	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the clock source.
Step 7	Switch(config-if)# **ces dsx1 framing** {**sf** | **esf**}	Configures the CES T1 framing type. The default is **esf**.
	Switch(config-if)# **ces dsx1 framing** {**e1_crc_mfCAS_lt** | **e1_crc_mf_lt** | **e1_lt** | **e1_mfCAS_lt**}	Configures the CES E1 framing type. For CES E1, the default is **e1_lt**.
Step 8	Switch(config-if)# **ces dsx1 linecode** {**ami** | **b8zs**}	Configures the CES T1 line code type. The default is **b8zs**.
	Switch(config-if)# **ces dsx1 linecode** {**ami** | **hdb3**}	Configures the CES E1 line code type. The default is **hdb3**.
Step 9	Switch(config-if)# **ces circuit** *circuit-id* **timeslots** *number*	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. • Time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. – For CES E1, the range is 1 through 31.
Step 10	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit name.

	Command	Purpose
Step 11	Switch(config-if)# **ces pvc** *circuit-id* **passive follow-ifstate**	Configures the destination (passive) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 12	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the destination (passive) side of a soft PVC for structured T1 CES, as shown in Figure 19-5:

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR3/0/0       UP        UP          T1
     CBR3/0/1       UP        UP          T1
     CBR3/0/2       UP        UP          T1
     CBR3/0/3       UP        UP          T1

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/3
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service structured
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces dsx1 framing esf
CESwitch(config-if)# ces dsx1 linecode b8zs
CESwitch(config-if)# ces circuit 1 timeslots 10-13
CESwitch(config-if)# ces circuit 1 circuit-name CBR-PVC-B
CESwitch(config-if)# no shutdown
CESwitch(config-if)# ces pvc 1 passive follow-ifstate
```

Phase 2—Configuring the Source (Active) Side of a Soft PVC

To configure the source (active) side of a soft PVC for structured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces address**	Shows the CES address for the destination end of the circuit. Use this command to retrieve the VPI/VCI of the destination port.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.

	Command	Purpose
Step 5	Switch(config-if)# **ces circuit** *circuit-id* **timeslots** *number*	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. **Note** The 0 circuit identifier is reserved for unstructured service. • Time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. – For CES E1, the range is 1 through 31.
Step 6	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit name.
Step 7	Switch(config-if)# **ces pvc** *circuit-id* **dest-address** *remote_atm_address* **vpi** *vpi* **vci** *vci* [**follow-ifstate**]	Configures the soft PVC to the destination CES-IWF ATM addresses and VPI/VCI of the circuit. Use the VPI/VCI of the destination port that was retrieved in Step 1. The **follow-ifstate** keyword configures the source (active) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 8	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the source (active) side of a soft PVC for structured CES, as shown in Figure 19-5:

```
CESwitch# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10  CBR3/0/3:1  vpi 0 vci 3088

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces circuit 1 timeslots 1-3, 7
CESwitch(config-if)# ces circuit 1 circuit-name CBR-PVC-A
CESwitch(config-if)# ces pvc 1 dest-address
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10 vpi 0 vci 16 follow-ifstate
CESwitch(config-if)# no shutdown
```

If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR3/0/0:1. For structured circuit emulation services, the circuit number sequence always begins at 1 for each port in a CES module.

Verifying a Soft PVC for Structured CES

To verify the soft PVC configured with structured CES, use the following EXEC commands:

Command	Purpose
show ces circuit	Shows the configuration information for the soft PVC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed interface configuration information for the soft PVC.

Examples

The following example shows the details of the CES circuit (shown in Figure 19-4), using the **show ces circuit** command:

```
CESwitch# show ces circuit

Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0    1       Active SoftVC   ATM-P3/0/3      0      3088  UP
 CBR3/0/3    1       Passive SoftVC  ATM-P3/0/3      0        16  UP
```

The following example shows the interface details for the source port (CBR 3/0/0) (shown in Figure 19-4), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 1
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-3,7
Channels used by this circuit: 1-3,7
Cell-Rate: 698, Bit-Rate 256000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 98
Active SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.10 vpi 0, vci 16
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10
```

The following example shows the interface details for the destination port (CBR 3/0/3) (shown in Figure 19-4), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/3 1
Circuit: Name CBR-PVC-B, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/3, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 10-13
Channels used by this circuit: 10-13
Cell-Rate: 698, Bit-Rate 256000
cas OFF, cell_header 0xC100 (vci = 3088)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 98
Passive SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10 vpi 0, vci 3088
```

```
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.00
```

Configuring a Soft PVC for Structured CES with CAS Enabled

Since the CES T1/E1 port adapter emulates CBR services over ATM networks, it must be able to support channel-associated signalling (CAS) information that is introduced into structured CES circuits by PBXs and TDMs. An optional CAS feature for the CES T1/E1 port adapter meets this requirement.

CAS information carried in a CBR bit stream can be configured with a CES module, as follows:

- The optional CAS feature is not enabled (the default state). For information about configuring a soft PVC for structured CES without CAS enabled, see the Configuring a Soft PVC for Structured CES, page 19-28.
- The optional CAS feature is enabled, but without the optional, Cisco-proprietary on-hook detection feature enabled. This option is described in the following procedure.
- Both the optional CAS and on-hook detection features are enabled. For information about configuring a soft permanent virtual channel (soft PVC) for structured CES with both CAS and on-hook detection enabled, see Configuring a Soft PVC for Structured CES with CAS and On-Hook Detection Enabled, page 19-37.

Note For a detailed description of CAS operation and the on-hook detection feature, refer to the circuit emulation services topic in the *Guide to ATM Technology*.

This section describes how to configure a soft PVC for structured CES with channel-associated signalling (CAS) enabled.

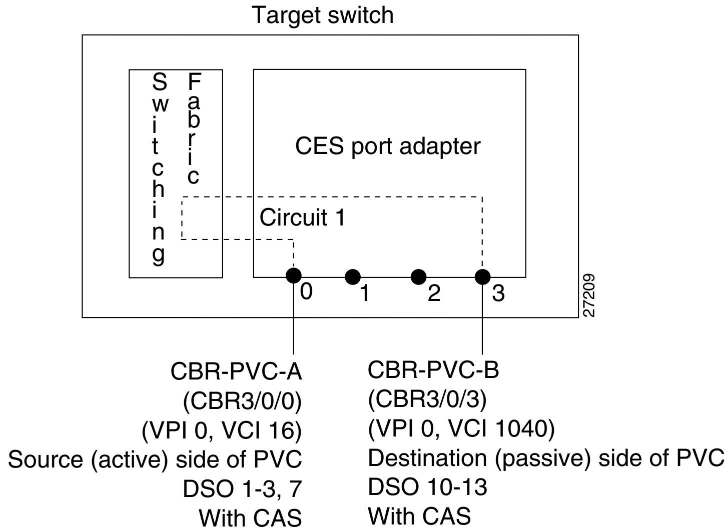
Note Typically you will configure a soft PVC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a soft PVC between modules in the same ATM switch router chassis.

The following procedure is based on the following assumptions:

- The source (active) side of the soft PVC (CBR-PVC-A) remains as previously configured.
- The destination (passive) side of the soft PVC (CBR-PVC-B) remains as previously configured.
- Four time slots (DS0 channels) remain as previously configured for the soft PVC:
  - For circuit CBR-PVC-A: DS0 channels 1 to 3 and 7 are used on port CBR3/0/0.
  - For circuit CBR-PVC-B: DS0 channels 10 to 13 are used on port CBR3/0/3.
- CAS is enabled for the circuit.
- The signalling mode for the T1 CBR ports is set to “robbedbit.”

Figure 19-6 shows a soft PVC configured for structured CES with CAS enabled.

Figure 19-6 Soft PVC Configured for Structured CES with CAS Enabled



To configure a soft PVC for structured CES with CAS enabled, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the ports to be configured with CAS enabled.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC mode prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the source interface to be configured.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.
Step 5	Switch(config-if)# **ces dsx1 signalmode robbedbit**	Configures the signal mode to robbedbit (CES T1 only).
Step 6	Switch(config-if)# **ces circuit** *circuit-id* **cas**	Enables channel-associated signalling.
Step 7	Switch(config-if)# **exit** Switch(config)#	Returns to global configuration mode.
Step 8	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the destination interface to be configured.
Step 9	Switch(config-if)# **shutdown**	Disables the interface.
Step 10	Switch(config-if)# **ces dsx1 signalmode robbedbit**	Configures the signal mode to robbedbit (CES T1 only).
Step 11	Switch(config-if)# **ces circuit** *circuit-id* **cas**	Enables channel-associated signalling.
Step 12	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to enable channel-associated signalling (CAS) on a soft PVC (see Figure 19-6):

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- --------- --------- ----------- -----------
     CBR3/0/0       UP        UP          T1   1-3,7
     CBR3/0/1     DOWN        UP          T1
     CBR3/0/2     DOWN        UP          T1
     CBR3/0/3       UP        UP          T1   10-13

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces dsx1 signalmode robbedbit
CESwitch(config-if)# ces circuit 1 cas
CESwitch(config-if)# no shutdown
CESwitch(config-if)# exit
CESwitch(config)# interface cbr 3/0/3
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces dsx1 signalmode robbedbit
CESwitch(config-if)# ces circuit 1 cas
CESwitch(config-if)# no shutdown
```

Verifying a Soft PVC for Structured CES with CAS Enabled

To verify the soft PVC with structured CES and CAS enabled, use the following EXEC commands:

Command	Purpose
show ces circuit	Shows the configuration information for the soft PVC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed interface configuration information for the soft PVC.

Examples

The following example displays the details of the CES circuit (shown in Figure 19-6), using the **show ces circuit** command at the privileged EXEC mode prompt:

```
CESwitch# show ces circuit

Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0     0       Active SoftVC   ATM-P3/0/3      0        16 UP
 CBR3/0/1     0       Passive SoftVC  ATM-P3/0/3      0      1040 UP
```

The following example displays the CAS status for the source port CBR 3/0/0 (shown in Figure 19-6):

```
CESwitch# show ces circuit interface cbr 3/0/0 1
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-3,7
Channels used by this circuit: 1-3,7
Cell-Rate: 698, Bit-Rate 256000
```

```
→ cas ON, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 98
Active SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.10 vpi 0, vci 16
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10
```

The following example displays the CAS status for the destination port CBR 3/0/3 (shown in Figure 19-6):

```
CESwitch# show ces circuit interface cbr 3/0/3 1
Circuit: Name CBR-PVC-B, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/3, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 10-13
Channels used by this circuit: 10-13
Cell-Rate: 698, Bit-Rate 256000
→ cas ON, cell_header 0xC100 (vci = 3088)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 98
Passive SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10 vpi 0, vci 3088
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.00
```

Configuring a Soft PVC for Structured CES with CAS and On-Hook Detection Enabled

This section outlines the additional steps that you must take to activate the on-hook detection (bandwidth-release) feature in a 1 x 64 structured CES circuit.

To configure a soft PVC for structured CES with CAS and on-hook detection enabled, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **shutdown**	Disables the interface.
Step 3	Switch(config-if)# **ces circuit** *circuit-id* [**cas**] [**on-hook-detect** *pattern*]	Configures channel-associated signalling and on-hook detection on the CES circuit.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure on-hook detection on the soft PVC with structured CES and CAS enabled in Configuring a Soft PVC for Structured CES with CAS Enabled, page 19-34 (shown in Figure 19-6):

```
CESwitch(config)# interface cbr 3/0/0
```

```
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces circuit 1 cas on-hook-detect 2
CESwitch(config-if)# no shutdown
```

Note The four ABCD bits in the CAS mechanism are device-specific, depending on the manufacturer of the voice/video telephony device that generates the CBR traffic. The ABCD bits of the CAS mechanism are user-configurable.

Verifying a Soft PVC for Structured CES with CAS and On-Hook Detection Enabled

To show the on-hook detection configuration of a soft PVC configured with structured CES and CAS enabled, use the following EXEC command:

Command	Purpose
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed interface configuration information for the soft PVC.

Example

The following example shows the soft PVC with CAS and on-hook detection enabled as hexadecimal number 2 (shown in Figure 19-6):

```
CESwitch# show ces circuit interface cbr 3/0/3 1
Circuit: Name CBR-PVC-B, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/3, Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 10-13
Channels used by this circuit: 10-13
Cell-Rate: 698, Bit-Rate 256000
→ cas ON, cell_header 0xC100 (vci = 3088)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
→ ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x2
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 98
Passive SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10 vpi 0, vci 3088
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.00
```

Creating Multiple Structured Soft PVCs on the Same CES Port

This section describes how to create more than one structured soft permanent virtual channel (soft PVC) on the same CES T1/E1 port. Figure 19-7 shows how you can configure multiple CES circuits on a single T1/E1 port.

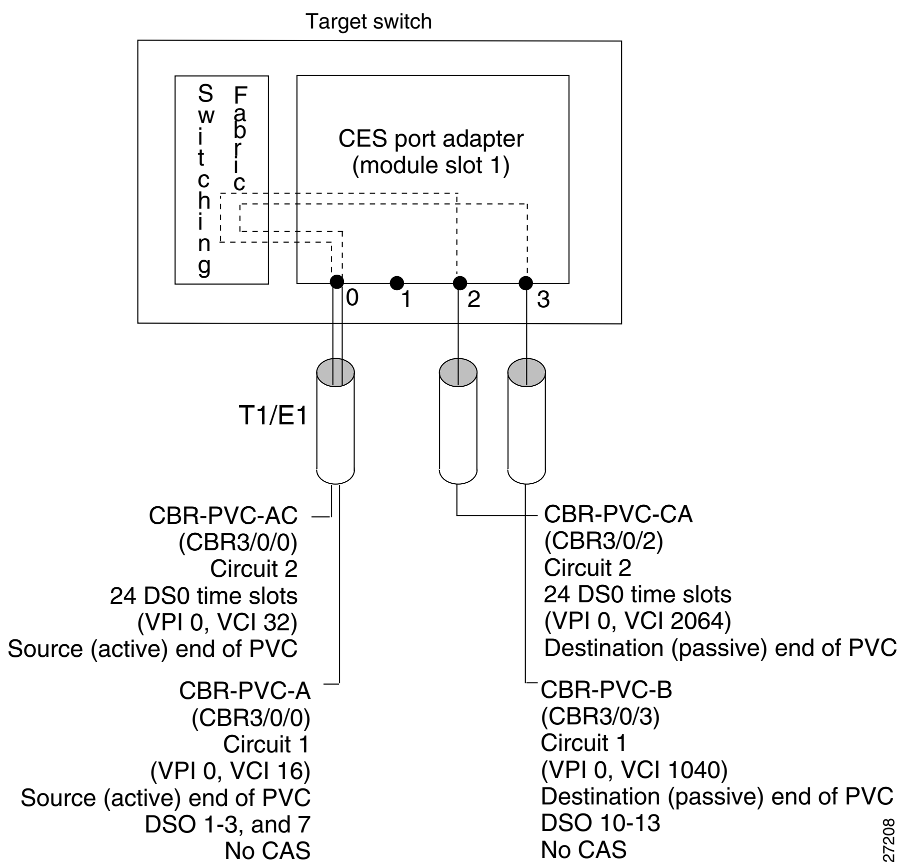
Note Typically you will configure a soft PVC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a soft PVC between modules in the same ATM switch router chassis.

Assume that certain configuration information has already been established for a soft PVC (see Figure 19-6) and that you are to create an additional soft PVC involving the same CES module.

The following assumptions apply to creating multiple soft PVCs on the same T1/E1 port (see Figure 19-7):

- The source (active) side of a soft PVC named CBR-PVC-A is already created on port CBR 3/0/0.
- The destination (passive) side of a soft PVC named CBR-PVC-B is already created on port CBR 3/0/3.
- A new source (active) side of a soft PVC named CBR-PVC-AC will be created on port CBR 3/0/0 of the CES module, thereby creating a multiple CES circuit on this particular port.
- A new destination (passive) side of a soft PVC named CBR-PVC-CA will be created on port CBR 3/0/2 of the CES module.
- The CES AAL1 service is structured and the clock source is network-derived.
- The CES framing is esf and the line code is b8zs.

Figure 19-7 Configuring Multiple Structured Soft PVCs on the Same CES T1/E1 Port



Configuring multiple soft PVCs for structured CES is a two-phase process:

- Phase 1—Configuring the Destination (Passive) Side of Multiple Soft PVCs, page 19-40
- Phase 2—Configuring the Source (Active) Side of Multiple Soft PVCs, page 19-41

Phase 1—Configuring the Destination (Passive) Side of Multiple Soft PVCs

To configure multiple soft PVCs on the destination (passive) side of the same port, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **shutdown**	Disables the interface.
Step 3	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 4	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the clock source.
Step 5	Switch(config-if)# **ces dsx1 framing** {**sf** | **esf**}	Configures the CES T1 framing type. The default is **esf**.
	Switch(config-if)# **ces dsx1 framing** {**e1_crc_mfCAS_lt** | **e1_crc_mf_lt** | **e1_lt** | **e1_mfCAS_lt**}	Configures the CES E1 framing type. The default is **e1_lt**.
Step 6	Switch(config-if)# **ces dsx1 linecode** {**ami** | **b8zs**}	Configures the CES T1 line code type. The default is **b8zs**.
	Switch(config-if)# **ces dsx1 linecode** {**ami** | **hdb3**}	Configures the CES E1 line code type. The default is **hdb3**.
Step 7	Switch(config-if)# **ces circuit** *circuit-id* [**circuit-name** *name*] [**timeslots** *number*]	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. **Note** The 0 circuit identifier is reserved for unstructured service. • Configures the CES interface circuit name. • Configures the time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. – For CES E1, the range is 1 through 31.
Step 8	Switch(config-if)# **ces pvc** *circuit-id* **passive follow-ifstate**	Configures the destination (passive) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 9	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure multiple soft PVCs on the destination (passive) side of the same port (shown in Figure 19-7):

```
CESwitch(config)# interface cbr 3/0/2
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service structured
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces dsx1 framing esf
CESwitch(config-if)# ces dsx1 linecode b8zs
CESwitch(config-if)# ces circuit 2 timeslots 24 circuit-name CBR-PVC-CA
CESwitch(config-if)# no shutdown
```

Note If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR3/0/2:1. For structured circuit emulation services, the circuit number sequence always begins at 1 for each port in a CES module.

Phase 2—Configuring the Source (Active) Side of Multiple Soft PVCs

To configure multiple soft PVCs on the source (active) side of the same port, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the source interface to be configured.
Step 2	Switch(config-if)# **shutdown**	Disables the interface.
Step 3	Switch(config-if)# **ces circuit** *circuit-id* [**circuit-name** *name*] [**timeslots** *number*]	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. • Configures the CES interface circuit name. • Configures the time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. – For CES E1, the range is 1 through 31.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.
Step 5	Switch(config-if)# **end** Switch#	Exits interface configuration mode.

	Command	Purpose
Step 6	Switch# **show ces address**	Shows the CES address for the destination end of the circuit. Use this command to retrieve the VPI/VCI of the destination port.
Step 7	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters configuration mode.
Step 8	Switch(config)# **interface cbr** *card***/***subcard***/***port* Switch(config-if)#	Selects the destination interface to be configured.
Step 9	Switch(config-if)# **shutdown**	Disables the interface.
Step 10	Switch(config-if)# **ces pvc** *circuit-id* **dest-address** *remote_atm_address* **vpi** *vpi* **vci** *vci* [**follow-ifstate**]	Configures the soft PVC to the destination CES-IWF ATM addresses and VPI/VCI of the circuit. Use the VPI/VCI of the destination port that was retrieved in Step 4.
Step 11	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure multiple soft PVCs on the source (active) side of the same port (shown in Figure 19-7):

```
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces circuit 2 timeslots 24
CESwitch(config-if)# ces circuit 2 circuit-name CBR-PVC-AC
CESwitch(config-if)# no shutdown
CESwitch(config-if)# end
CESwitch# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1030.10  CBR-PVC-A
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1030.20  CBR-PVC-AC
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1034.10  CBR-PVC-B
47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1038.10  CBR-PVC-CA

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/2
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces pvc 2 dest-address
 47.0091.8100.0000.0060.5c71.1f01.4000.0c80.1038.10 vpi 0 vci 2064
CESwitch(config-if)# no shutdown
```

If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR3/0/2:1. For structured circuit emulation services, the circuit number sequence always begins at 1 for each port in a CES module.

Verifying the Creation of Multiple Structured Soft PVCs on the Same CES Port

To verify multiple structured soft PVCs with CAS enabled, use the following EXEC commands:

Command	Purpose
show ces circuit	Shows the configuration information for the soft PVC.
show ces address	Shows the CES address for the destination end of the circuit.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows the detailed interface configuration information for the soft PVC.

Examples

The following example displays the circuit details for the soft PVCs that you created in the previous procedure (shown in Figure 19-7) using the **show ces circuit** command in privileged EXEC mode:

```
CESwitch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR3/0/0    1       Active SoftVC   ATM-P3/0/3      0      3088  UP
 CBR3/0/0    2       Active SoftVC   ATM-P3/0/3      0      2080  UP
 CBR3/0/2    2       Passive SoftVC  ATM-P3/0/3      0        32  UP
 CBR3/0/3    1       Passive SoftVC  ATM-P3/0/3      0        16  UP
```

The following example displays the CES-IWF addresses of the soft PVCs that you configured (shown in Figure 19-7), using the **show ces address** command in privileged EXEC mode:

```
CESwitch# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.10  CBR3/0/0:1  vpi 0 vci 16
47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.20  CBR3/0/0:2  vpi 0 vci 32
47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8038.20  CBR3/0/2:2  vpi 0 vci 2080
47.0091.8100.0000.00e0.4fac.b401.4000.0c81.803c.10  CBR3/0/3:1  vpi 0 vci 3088
```

The following example displays the interface details for the new circuit 2 soft PVC that you set up on port CBR 3/0/0 (shown in Figure 19-7), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 2
Circuit: Name CBR-PVC-AC, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/0, Circuit_id 2, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 24
Channels used by this circuit: 24
Cell-Rate: 172, Bit-Rate 64000
cas OFF, cell_header 0x200 (vci = 32)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       81, startDequeueDepth       64
Partial Fill:       47, Structured Data Transfer 1
Active SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.20 vpi 0, vci 32
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8038.20
```

The following example displays the interface details for the new circuit 1 soft PVC that you configured on port CBR3/0/2 (shown in Figure 19-7), using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/2 2
Circuit: Name CBR-PVC-CA, Circuit-state ADMIN_UP / oper-state UP
Interface CBR3/0/2, Circuit_id 2, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 24
```

```
Channels used by this circuit: 24
Cell-Rate: 172, Bit-Rate 64000
cas OFF, cell_header 0x8200 (vci = 2080)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavailable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       81, startDequeueDepth       64
Partial Fill:       47, Structured Data Transfer 1
Passive SoftVC
Src: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8038.20 vpi 0, vci 2080
Dst: atm addr 47.0091.8100.0000.00e0.4fac.b401.4000.0c81.8030.00
```

Configuring T1/E1 CES SVCs

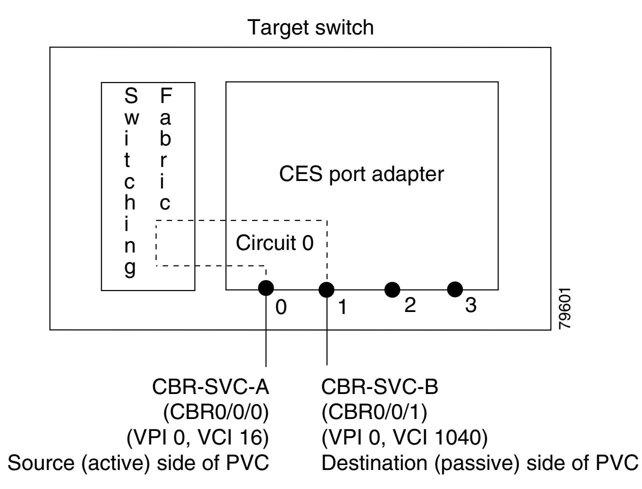
A CES module converts CBR traffic into ATM cells for propagation through an ATM network. CBR traffic arriving on a CES module port must first be segmented into ATM cells. This cell stream is then directed to an outgoing ATM or CBR port.

Configuring T1/E1 Unstructured CES SVCs

Figure 19-8 displays a switched VC configured for unstructured CES. The switched VC uses adaptive clocking and the source clock is network-derived.

Note Typically you configure a switched VC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a switched VC between modules in the same ATM switch router chassis.

Figure 19-8 Switched VC Configured for Unstructured CES



Configuring a switched VC for unstructured CES is a two-phase process:

- Phase 1—Configuring the Destination (Passive) Side of the Unstructured Switched VC, page 19-45
- Phase 2—Configuring the Source (Active) Side of the Unstructured Switched VC, page 19-46

Phase 1—Configuring the Destination (Passive) Side of the Unstructured Switched VC

To configure the destination (passive) side of an unstructured switched VC destination port, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about current CBR interfaces. Use this command to choose the destination port.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 6	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures the CES interface AAL1 clock mode.
Step 7	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Switch(config-if)# **ces svc** *circuit-id* **passive follow-ifstate**	Configures the destination (passive) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the destination (passive) side of an unstructured switched VC, as shown in Figure 19-8:

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR0/0/0       UP        UP           T1
     CBR0/0/1       UP        UP           T1
     CBR0/0/2       UP        UP           T1
     CBR0/0/3       UP        UP           T1

CESwitch# configure terminal
CESwitch(config)# interface cbr 0/0/1
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service unstructured
CESwitch(config-if)# ces aal1 clock synchronous
```

```
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces circuit 0 circuit-name CBR-SVC-B
CESwitch(config-if)# no shutdown
```

Note If you do not specify the circuit name and logical name parameters in the command line, the system automatically assigns a unique default name in the form CBR*x/y/z:#* for the circuit being configured. For example, the default name for this particular circuit is CBR0/0/1:0.

Phase 2—Configuring the Source (Active) Side of the Unstructured Switched VC

To configure the source (active) side of an unstructured switched VC destination port, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the source CBR port.
Step 2	Switch# **show ces address**	Shows the CES address and VPI/VCI for the destination end of the circuit.
Step 3	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 4	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 5	Switch(config-if)# **shutdown**	Disables the interface.
Step 6	Switch(config-if)# **ces aal1 service unstructured**	Configures the CES interface AAL1 service type.
Step 7	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	(Optional) Configures the AAL1 clock mode.
Step 8	Switch(config-if)# **ces circuit 0** [**cas**] [**cdv** *max-req*] [**circuit-name** *name*] [**partial-fill** number] [**shutdown**] [**timeslots** *number*] [**on-hook-detect** *pattern*]	Configures the following CES connection attributes for the circuit: Circuit id number 0 and circuit name. Enables channel-associated signalling for structured service only. The default is no **cas**. Enables the peak-to-peak cell delay variation (CDV) requirement. The default is 2000 milliseconds.
Step 9	Switch(config-if)# **ces svc** *circuit-id* **dest-address** *atm-address* [**hold-priority** *priority*] [**follow-if-state**] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Configures the switched VC to the CBR interface.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the switched VC for unstructured CES (shown in Figure 19-8):

Step 1 Use the **show ces status** command to confirm CES interface CBR 0/0/0 is up.

```
Switch# show ces status
   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type       use
------------- -------- --------- ----------- -----------
     CBR0/0/0       UP        UP          T1
     CBR0/0/1       UP        UP          T1
     CBR0/0/2       UP        UP          T1
     CBR0/0/3       UP        UP          T1
```

Step 2 Use the **show ces address** command to determine the ATM address of the target CBR interface 0/0/1.

```
Switch# show ces addresses

.
[Information Deleted]
.
CES-IWF ATM Address(es):
47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10  CBR0/0/1:0  vpi 0 vci 1040
.
[Information Deleted]
.
```

Step 3 Use the following commands to configure the switched VC on CES interface CBR 0/0/0:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface cbr 0/0/0
Switch(config-if)# shutdown
Switch(config-if)# ces aal1 service unstructured
Switch(config-if)# ces circuit 0 circuit-name CBR-SVC-A
Switch(config-if)# ces svc 0 dest-address 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10
Switch(config-if)# no shutdown
Switch(config-if)# end
Switch#
```

These commands perform the following processes:

- Select the interface to configure.
- Shut down the interface.
- Configure the CES as unstructured.
- Configure the circuit number and circuit name.
- Configure the SVC circuit ID to an CBR interface destination ATM address.
- Re-enable the interface.

Confirm that the CES switched VC is functioning correctly using the commands in the following section.

Verifying a Switched VC for Unstructured CES

To verify the unstructured switched VC configuration, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows configuration information for the switched VC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows detailed interface configuration information for the switched VC.

Examples

The following example shows how to display the basic information about the switched VC shown in Figure 19-8, using the **show ces circuit** command:

```
Switch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR0/0/0     0       Active SVC      ATM-P0/0/3      0      1040  UP
 CBR0/0/1     0       Passive SoftVC  ATM-P0/0/3      0        16  UP
```

The output from this command verifies the source (CBR 0/0/0) and destination (CBR 0/0/1) port IDs of the switched VC and indicates that the circuit is up.

The following example shows how to display detailed information about the switched VC shown in Figure 19-8, using the **show ces circuit interface** command:

```
Switch# show ces circuit interface cbr 0/0/0 0
Circuit: Name CBR-SVC-A, Circuit-state ADMIN_UP / oper-state UP Interface CBR0/0/0,
Circuit_id 0, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-24
Channels used by this circuit: 1-24
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV 331 usecs
De-jitter: UnderFlow 0, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 0
Active SVC
Src: atm addr 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0030.10 vpi 0, vci 16
Dst: atm addr 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10
```

The output from this command verifies the following configuration information:

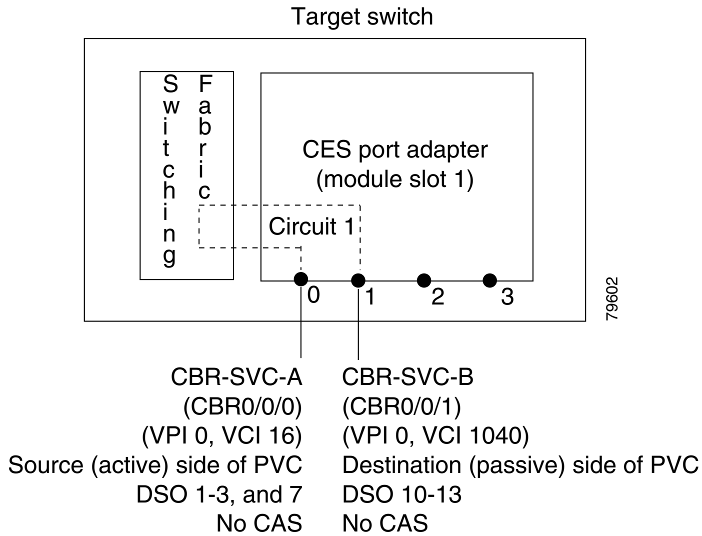
- The circuit named CBR-SVC-A is in an UP state.
- The interface CBR 0/0/0 has a circuit id of 0 (because the entire bandwidth of the port is dedicated to that circuit).
- The source port for the switched VC is CBR 0/0/0. The Dst (destination) ATM address is 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10.

Configuring T1/E1 Structured CES SVCs

Figure 19-9 shows an example of a switched VC configured for structured CES.

Note Typically you configure a switched VC between CES modules anywhere in your network. For simplicity, this example and the accompanying procedure describe how to create a switched VC between modules in the same ATM switch router chassis.

Figure 19-9 Switched VC Configured for Structured CES



Configuring a switched VC for structured CES is a two-phase process:

- Phase 1—Configuring the Destination (Passive) Side of the Structured Switched VC, page 19-49
- Phase 2—Configuring the Source (Active) Side of the Structured Switched VC, page 19-51

Phase 1—Configuring the Destination (Passive) Side of the Structured Switched VC

To configure a destination (passive) side of a switched VC for structured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the destination port.
Step 2	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 3	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **ces aal1 service** {**structured** | **unstructured**}	Configures the CES interface AAL1 service type.
Step 6	Switch(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the clock source.
Step 7	Switch(config-if)# **ces dsx1 framing** {**sf** | **esf**}	Configures the CES T1 framing type. The default is **esf**.
	Switch(config-if)# **ces dsx1 framing** {**e1_crc_mfCAS_lt** | **e1_crc_mf_lt** | **e1_lt** | **e1_mfCAS_lt**}	Configures the CES E1 framing type. For CES E1, the default is **e1_lt**.

	Command	Purpose
Step 8	Switch(config-if)# **ces dsx1 linecode** {**ami** | **b8zs**}	Configures the CES T1 line code type. The default is **b8zs**.
	Switch(config-if)# **ces dsx1 linecode** {**ami** | **hdb3**}	Configures the CES E1 line code type. The default is **hdb3**.
Step 9	Switch(config-if)# **ces circuit** *circuit-id* **timeslots** *number*	Configures the following CES connection attributes for the circuit: • Circuit id number. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. • Time slots for the circuit for structured service only. – For CES T1, the range is 1 through 24. – For CES E1, the range is 1 through 31.
Step 10	Switch(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit name.
Step 11	Switch(config-if)# **ces svc** *circuit-id* **passive follow-ifstate**	Configures the destination (passive) port circuit status to follow the status of the physical interface. The default circuit setting ignores the status of the physical interface.
Step 12	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the destination (passive) side of a switched VC for structured T1 CES, as shown in Figure 19-9:

```
CESwitch# show ces status

   Interface      IF      Admin        Port  Channels in
     Name       Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR0/0/0       UP        UP          T1
     CBR0/0/1       UP        UP          T1
     CBR0/0/2       UP        UP          T1
     CBR0/0/3       UP        UP          T1

CESwitch# configure terminal
CESwitch(config)# interface cbr 0/0/1
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces aal1 service structured
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces dsx1 framing esf
CESwitch(config-if)# ces dsx1 linecode b8zs
CESwitch(config-if)# ces circuit 1 timeslots 10-13
CESwitch(config-if)# ces circuit 1 circuit-name CBR-SVC-A
CESwitch(config-if)# no shutdown
CESwitch(config-if)# ces svc 1 passive follow-ifstate
```

Phase 2—Configuring the Source (Active) Side of the Structured Switched VC

The example connection shown in Figure 19-9 is used in the following example configuration.

To configure a switched VC for structured CES, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces status**	Displays information about the current CBR interfaces. Use this command to choose the source CBR port.
Step 2	Switch# **show ces address**	Shows the CES address and VPI/VCI for the destination end of the circuit.
Step 3	Switch# **configure terminal** Switch(config)#	At the privileged EXEC prompt, enters global configuration mode.
Step 4	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 5	Switch(config-if)# **shutdown**	Disables the interface.
Step 6	Switch(config-if)# **ces aal1 service structured**	Configures the CES interface AAL1 service type.
Step 7	Switch(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	(Optional) Configures the AAL1 clock mode.
Step 8	Switch(config-if)# **ces circuit** *circuit-id* [**cas**] [**cdv** *max-req*] [**circuit-name** *name*] [**partial-fill** number] [**shutdown**] [**timeslots** *number*] [**on-hook-detect** *pattern*]	Configures the following CES connection attributes for the circuit: Circuit id number. • For CES T1 structured service, use 1 through 24. • For CES E1 structured service, use 1 through 31. Configures the circuit name. Enables channel-associated signalling for structured service only. The default is no **cas**. Enables the peak-to-peak cell delay variation (CDV) requirement. The default is 2000 milliseconds.
Step 9	Switch(config-if)# **ces svc** *circuit-id* **dest-address** *atm-address* [**hold-priority** *priority*] [**follow-if-state**] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]]	Configures the switched VC to the CBR interface.
Step 10	Switch(config-if)# **no shutdown**	Reenables the interface.

Example

The following example shows how to configure the switched VC for structured CES (shown in Figure 19-9):

Step 1 Use the **show ces status** command to confirm CES interface CBR 0/0/0 is up.

```
Switch# show ces status
   Interface      IF      Admin         Port  Channels in
     Name        Status   Status        Type       use
------------- --------- --------- ----------- -----------
     CBR0/0/0       UP        UP           T1
     CBR0/0/1     DOWN        UP           T1
     CBR0/0/2     DOWN        UP           T1
     CBR0/0/3       UP        UP           T1
```

Step 2 Use the **show ces address** command to determine the ATM address of target CBR interface 0/0/1.

```
Switch# show ces addresses

.
[Information Deleted]
.
CES-IWF ATM Address(es):
47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10  CBR0/0/1:1  vpi 0 vci 1040
.
[Information Deleted]
.
```

Step 3 Use the following commands to configure the structured switched VC on CES interface CBR 0/0/0:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface cbr 0/0/0
Switch(config-if)# shutdown
Switch(config-if)# ces aal1 service structured
Switch(config-if)# ces circuit 1 timeslots 1-3,7
Switch(config-if)# ces circuit 1 circuit-name CBR-SVC-B
Switch(config-if)# ces svc 1 dest-address 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10
Switch(config-if)# no shutdown
Switch(config-if)# end
Switch#
```

These commands perform the following processes:

- Select the interface to configure.
- Shut down the interface.
- Configure the CES as structured.
- Configure the circuit number and time slots 1,2,3, and 7.
- Configure the Circuit name.
- Configure the SVC circuit ID to a CBR interface destination ATM address.
- Re-enable the interface.

Confirm the CES switched VC is functioning correctly using the commands in the following section.

Verifying a Switched VC for Structured CES

To verify the switched VC configuration, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows configuration information for the switched VC.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows detailed interface configuration information for the switched VC.

Examples

The following example shows how to display the basic information about the structured switched VC shown in Figure 19-9, using the **show ces circuit** command:

```
Switch# show ces circuit
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR0/0/0     1      Active SVC      ATM-P0/0/3      0      1040  UP
 CBR0/0/1     1      Passive SoftVC  ATM-P0/0/3      0        16  UP
```

The output from this command verifies the source (CBR 0/0/0) and destination (CBR 0/0/1) port IDs of the switched VC and indicates that the circuit is up.

The following example shows how to display detailed information about the structured switched VC shown in Figure 19-9, using the **show ces circuit interface** command:

```
Switch# show ces circuit interface cbr 0/0/0 1
Circuit: Name CBR-SVC-A, Circuit-state ADMIN_UP / oper-state UP Interface CBR0/0/0,
Circuit_id 1, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-3,7
Channels used by this circuit: 1-3,7
Cell-Rate: 683, Bit-Rate 256000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow unavailable, OverFlow unavaliable
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcActive, maxQueueDepth       45, startDequeueDepth       28
Partial Fill:       47, Structured Data Transfer 4
Active SVC
Src: atm addr 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0030.10 vpi 0, vci 16
Dst: atm addr 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10
```

The output from this command verifies the following configuration information:

- The circuit named CBR-SVC-A is in an UP state.
- The interface CBR 0/0/0 has a circuit id of 1 using channels 1, 2, 3, and 7.
- The source port for the switched VC is CBR 0/0/0. The destination ATM address is 47.0091.8100.0000.0004.ddec.d301.4000.0c80.0034.10.

Reconfiguring a Previously Established Circuit

Once you have configured a circuit, you cannot change the circuit's configuration while the circuit is up. You must first bring the interface down. Then you can change the circuit configuration. After entering these configuration changes, you must bring the interface back up. To change an enabled circuit's configuration, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **shutdown**	Disables the CES interface.
Step 3	For example, to specify the clock source as network-derived and to change the AAL1 clocking mode from adaptive to synchronous, enter: Switch(config-if)# **ces dsx1 clock source network-derived** Switch(config-if)# **ces aal1 clock synchronous**	Configures the clock source as network-derived and reconfigures the AAL1 clock mode to synchronous.
Step 4	Switch(config-if)# **no shutdown**	Enables the CES interface.
Step 5	Switch(config-if)# **end** Switch#	Exits interface configuration mode and returns to privileged EXEC mode.
Step 6	Switch# **show ces circuit interface cbr** *card/subcard/port circuit-id*	Shows detailed interface configuration information for the circuit. Use this command to verify your configuration changes.

Note The **no ces circuit** *circuit-id* **shutdown** command *deletes* the circuit. If you use this command, you must reenter all of the configuration information for the circuit. Do not use this command unless you intend to delete the circuit.

Examples

The following example disables interface cbr 3/0/0, specifies the clock source as network-derived, changes the AAL1 clocking method to synchronous, and reenables the interface.

```
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# shutdown
CESwitch(config-if)# ces dsx1 clock source network-derived
CESwitch(config-if)# ces aal1 clock synchronous
CESwitch(config-if)# no shutdown
```

The following example displays the changed configuration information for the circuit, using the **show ces circuit interface cbr** command:

```
CESwitch# show ces circuit interface cbr 3/0/0 0
Circuit: Name CBR-PVC-A, Circuit-state ADMIN_UP /
Interface CBR3/0/0, Circuit_id 0, Port-Type T1, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-24
Channels used by this circuit: 1-24
```

```
Cell-Rate: 4107, Bit-Rate 1544000
cas OFF, cell_header 0x100 (vci = 16)
cdv 2000 usecs, Measured cdv 350 usecs
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      879, startDequeueDepth      491
Partial Fill:       47, Structured Data Transfer 0
HardPVC
src: CBR3/0/0 vpi 0, vci 16
Dst: ATM0/1/3 vpi 0, vci 100
```

The output from this command verifies the following configuration information:

- The circuit named CBR-PVC-A is UP.
- The clock source is network-derived.
- The AAL1 clocking method is synchronous.

Deleting a Previously Established Circuit

This section describes how to delete a previously established circuit.

To delete a previously established circuit, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show ces circuit**	Shows the configuration information for the circuit.
Step 2	Switch# **configure terminal** Switch(config)#	Enters global configuration mode from the terminal.
Step 3	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface where the circuit is to be deleted.
Step 4	Switch(config-if)# **no ces circuit** *circuit-id*	Deletes the CES circuit.
Step 5	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode and returns to global configuration mode.
Step 6	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the other physical interface where the circuit is to be deleted.
Step 7	Switch(config-if)# **no ces circuit** *circuit-id*	Deletes the other end of CES circuit.

Example

The following example shows how to delete a previously established circuit:

```
CESwitch# show ces circuit

Interface  Circuit  Circuit-Type X-interface X-vpi X-vci Status
CBR3/0/0     0        HardPVC      ATM0/0      0     100   UP
CBR3/0/3     0        HardPVC      ATM0/0      0     101   UP

CESwitch# configure terminal
CESwitch(config)# interface cbr 3/0/0
CESwitch(config-if)# no ces circuit 0
CESwitch(config-if)# exit
CESwitch(config)# interface cbr 3/0/3
```

```
CESwitch(config-if)# no ces circuit 0
```

Verifying Deletion of a Previously Established Circuit

To verify the deletion of a previously configured circuit, use the following privileged EXEC commands:

Command	Purpose
show ces circuit	Shows the configuration information for the circuit.
show ces address	Shows the configuration information for any CES addresses.

Examples

The following example displays the configuration of any CES circuits:

```
CESwitch# show ces circuit
```

The absence of output verifies that all CES circuits are deleted.

The following example displays the configuration of any CES addresses:

```
CESwitch# show ces address

CES-IWF ATM Address(es):
```

The absence of output verifies that all CES circuits are deleted.

Configuring SGCP

The Simple Gateway Control Protocol (SGCP) controls voice-over-IP gateways by an external call control element (called a call-agent). This has been adapted to allow SGCP to control ATM switch router circuit emulation services (CES) circuits (called endpoints in SGCP). The resulting system (call-agents and gateways) allows for the call-agent to engage in common channel signalling (CCS) over a 64-Kbps CES circuit, governing the interconnection of bearer channels on the CES interface. In this system the ATM switch router acts as a voice-over-ATM gateway.

For overview information about configuring the SCGP feature, refer to the *Guide to ATM Technology*.

Operation

The network operator can globally enable or disable SGCP operation for the switch. By default, SGCP is disabled. When SGCP is enabled, the ATM switch router begins listening on the well-known User Datagram Protocol (UDP) port for SGCP packets. The endpoint ID in an SGCP packet identifies the CES circuit. The CES circuit endpoint can be used by SGCP if the following conditions exist:

- The parent CES interface is enabled, and the LineState field indicates NoAlarm (determined via the **show ces interface** command).
- The CES circuit is allocated a single time slot.
- The CES circuit is enabled (not shut).
- The CES circuit is not configured as an active soft PVC.

- The CES circuit is not configured as part of a hard PVC.

The following sections describe SGCP configuration tasks:

- Configuring SGCP on the Entire Switch, page 19-57
- Displaying SGCP, page 19-57
- Configuring CES Circuits for SGCP, page 19-58
- Displaying SGCP Endpoints, page 19-59
- Displaying SGCP Connections, page 19-60
- Configuring SGCP Request Handling, page 19-60
- Configuring Call-Agent Address, page 19-60
- Shutting Down SGCP, page 19-61

Configuring SGCP on the Entire Switch

To enable SGCP operations for the entire switch, use the following global configuration command:

Command	Purpose
sgcp	Enables or disables SGCP operations for the entire switch.

Example

The following example shows how to enable SGCP for the entire switch:

```
Switch(config)# sgcp
```

Displaying SGCP

To display SGCP configuration, operational state, and a summary of connection activity, use the following privileged EXEC command:

Command	Purpose
show sgcp	Displays the global SGCP configuration.

Example

The following example displays the SGCP configuration:

```
Switch# show sgcp

SGCP Admin State ACTIVE, Oper State ACTIVE
SGCP call-agent:none  , SGCP graceful-shutdown enabled? FALSE
SGCP request timeout 2000, SGCP request retries 6
74 CES endpoint connections created
74 CES endpoints in active connections
```

Configuring CES Circuits for SGCP

Any single time slot (64 Kbps) allocated to a circuit on a CES T1/E1 interface can be configured for SGCP with these restrictions:

- CES is not the active source end of a soft PVC.
- CES is not part of a hard PVC.

Note Configuration on the call-agent can restrict the range of circuits designated for signalling on a CES circuit interface.

When you configure a CES circuit for SGCP, signalling should be given the proper time slot. For T1 CES circuits, a time slot can be given a number from 1 to 24; for E1 CES, a number from 1 to 31.

Although no keyword identifies a CES circuit as allocatable by SGCP, there is normally a simple configuration rule to ensure that signalling allocates the proper time slot:

circuit *x* is allocated time slot *x*, 1<=*x*<=24 (or 31 for E1).

Note The endpoint specifier used by SGCP refers to the CES circuit ID (not the time slot). If a time slot is not allocated to a circuit, that time slot cannot be used by SGCP (or CES, either).

To configure SGCP operation on a CES circuit interface, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card*/*subcard*/*port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **ces aal1 service structured**	Configures the AAL1 service type.
Step 3	Switch(config-if)# **ces circuit** *circuit-id* **timeslot** *number*	Allocates a time slot number to the circuit identifier.

Example

The following example shows how to configure the CES port for structured CES with all time slots available for SGCP. CES circuit 16 is configured for common channel signalling and specified as a soft permanent virtual channel (soft PVC) to a circuit on the CES port adapter connected to the call-agent.

```
Switch(config)# interface cbr 1/1/2
Switch(config-if)# ces aal1 service structured
Switch(config-if)# ces circuit 1 timeslot 1
Switch(config-if)# ces circuit 2 timeslot 2
Switch(config-if)# ces circuit 3 timeslot 3
Switch(config-if)# ces circuit 4 timeslot 4
Switch(config-if)# ces circuit 5 timeslot 5
Switch(config-if)# ces circuit 6 timeslot 6
Switch(config-if)# ces circuit 7 timeslot 7
Switch(config-if)# ces circuit 8 timeslot 8
Switch(config-if)# ces circuit 9 timeslot 9
Switch(config-if)# ces circuit 10 timeslot 10
Switch(config-if)# ces circuit 11 timeslot 11
Switch(config-if)# ces circuit 12 timeslot 12
Switch(config-if)# ces circuit 13 timeslot 13
```

```
Switch(config-if)# ces circuit 14 timeslot 14
Switch(config-if)# ces circuit 15 timeslot 15
Switch(config-if)# ces circuit 16 timeslot 16
Switch(config-if)# ces pvc 16 dest-address
47.0091.8100.0000.0060.3e64.fd01.4000.0c80.1038.10 vpi 0 vci 2064
Switch(config-if)# ces circuit 17 timeslot 17
Switch(config-if)# ces circuit 18 timeslot 18
Switch(config-if)# ces circuit 19 timeslot 19
Switch(config-if)# ces circuit 20 timeslot 20
Switch(config-if)# ces circuit 21 timeslot 21
Switch(config-if)# ces circuit 22 timeslot 22
Switch(config-if)# ces circuit 23 timeslot 23
Switch(config-if)# ces circuit 24 timeslot 24
Switch(config-if)# end
```

Displaying SGCP Endpoints

SGCP endpoints are all the CES circuits that might be eligible for SGCP connections. To display SGCP endpoints, use the following EXEC command:

Command	Purpose
show sgcp endpoint [**interface cbr** *card***/***subcard***/***port* [*circuit-id*]]	Displays the SGCP endpoints.

Note SGCP cannot allocate a CES circuit to a connection if it is already part of a hard or soft PVC.

Example

The following example displays the possible SGCP endpoints on CES interface CBR 1/1/0:

```
Switch> show sgcp endpoint interface cbr 1/1/0

Endpt         Timeslots Conn State           Call ID
CBR1.1.0/1         1    no connection
CBR1.1.0/2         1    no connection
CBR1.1.0/3         1    no connection
CBR1.1.0/4         1    no connection
CBR1.1.0/5         1    no connection
CBR1.1.0/6         1    no connection
CBR1.1.0/7         1    no connection
CBR1.1.0/8         1    no connection
CBR1.1.0/9         1    no connection
CBR1.1.0/10        1    no connection
CBR1.1.0/11        1    active
CBR1.1.0/12        1    no connection
CBR1.1.0/14        1    active             1234abc
CBR1.1.0/15        1    active             2234abc
CBR1.1.0/16        1    active             3234abc
CBR1.1.0/17        1    active             4234abc
CBR1.1.0/18        1    active             5234abc
CBR1.1.0/19        1    active             6234abc
CBR1.1.0/20        1    active             7234abc
CBR1.1.0/21        1    active             8234abc
CBR1.1.0/22        1    active             9234abc
CBR1.1.0/23        1    active             a234abc
```

```
CBR1.1.0/24        1    active            b234abc
```

Displaying SGCP Connections

To display SGCP connections (either globally or per single interface), use the following EXEC command:

Command	Purpose
show sgcp connection [**interface cbr** *card*/*subcard*/*port*]	Displays the SGCP connections.

Example

The following example displays all SGCP connections created on the ATM switch router:

```
Switch> show sgcp connection

Conn Endpt          Soft VC State        Call Id
CBR0.0.0/1         Dest- active VC       d234ab
CBR0.0.0/2         Dest- active VC       12345bc
CBR0.0.0/3         Dest- active VC       1284ab
CBR0.0.0/4         Dest- active VC       9234abc
```

Configuring SGCP Request Handling

When the ATM switch router initiates an SGCP request (for example, to disconnect the circuit), default request timer and request retry values are in operation. To change the default value of SGCP requests, use the global configuration commands, as shown in the following table:

Command	Purpose
sgcp request timeout *msecs*	Configures the SGCP request timeout value.
sgcp request retries *number*	Configures the SGCP request retry value.

Examples

The following example shows how to change the request timeout to 2000 milliseconds:

```
Switch(config)# sgcp request timeout 2000
```

The following example shows how to change the request retry value to 5:

```
Switch(config)# sgcp request retries 5
```

Configuring Call-Agent Address

By default the SGCP call agents perform the following tasks:

- The ATM switch router sends a response to an SGCP request in a UDP packet with the destination address the same as the source address of the request UDP packet.

- To send a DeleteConnection request for a connection that exists, the ATM switch router specifies the destination address of the UDP packet as the source UDP address in the CreateConnection request.

To alter this behavior, and send responses and requests to a specific IP address and UDP port, use the following global configuration command:

Command	Purpose
sgcp call-agent *ip-address udp-port*	Configures the call-agent IP address and UDP port.

Note If the IP address is specified without the UDP port number, the well-known SGCP port 2427 is used.

Example

The following example shows how to set the call-agent with IP address 133.20.5.122 and UDP port 12000:

```
Switch(config)# sgcp call-agent 133.20.5.122 12000
```

Shutting Down SGCP

When SGCP is disabled with the **no sgcp** command, active SGCP connections are terminated; however DeleteConnection requests are not sent to the call-agent for these active connections. To notify call-agent and perform a graceful SGCP shutdown, use the following global configuration command:

Command	Purpose
sgcp graceful-shutdown	Shuts down SGCP and notifies call-agent.

Example

The following example shows how to perform a graceful shutdown:

```
Switch(config)# sgcp graceful-shutdown
```

Configuring Explicit Paths on CES VCs

The explicit path feature enables you to manually configure either a fully specified or partially specified path for routing CES soft permanent virtual channels (soft PVC) and SVC connections. Once these routes are configured, up to three explicit paths might be applied to these CES connections.

A fully specified path includes all adjacent nodes for all segments of the path. A partially specified path consists of one or more segment target nodes that should appear in their proper order in the explicit path. The standard routing algorithm determines all unspecified parts of the partially specified path.

You can specify a path name for an explicit path and the switch assigns the next available unused *path-id* value, or you can choose the *path-id* value and assign or modify its name.

For overview information about explicit paths, refer to the *Guide to ATM Technology*. For additional explicit path configuration information, see the "Configuring Explicit Paths" section on page 11-36.

Configuring CES VC Explicit Paths

To configure CES VC explicit paths, follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the physical interface to configure.
Step 2	Switch(config-if)# **ces circuit** *circuit-id* [**cas**] [**cdv** *max-req*] [**circuit-name** *name*] [**partial-fill** *number*] [**shutdown**] [**timeslots** *number*] [**on-hook-detect** *pattern*]	Configures the following CES connection attributes for the circuit: • Circuit ID number. – For unstructured service, use 0. – For CES T1 structured service, use 1 through 24. – For CES E1 structured service, use 1 through 31. • Enables channel-associated signaling for structured service only. The default is no channel-associated signaling. • Enables the peak-to-peak cell delay variation requirement. The default is 2000 milliseconds.
Step 3	Switch(config-if)# **ces pvc** *circuit-id* **dest-address** *atm-address* [[**vpi** *vpi-number*] **vci** *vci-number*] [**follow-ifstate**] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]] **redo-explicit** [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**] or **ces svc** *circuit-id* **dest-address** *atm-address* [**hold-priority** *priority*] [**follow-if-state**] [**retry-interval** [**first** *retry-interval*] [**maximum** *retry-interval*]] **redo-explicit** [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**]	Configures a CES soft PVC or CES SVC (switched VC) explicit path connection.
Step 4	Switch(config-if)# **end** Switch#	Exits interface configuration mode.

Example

The following example shows how to set a CES switched VC with an explicit path on CBR interface 3/1/0.

```
Switch(config)# interface cbr3/1/0
Switch(config-if)# ces circuit 6 timeslots 6
Switch(config-if)# ces svc 6 dest-address
47.0091.8100.0000.0010.073c.0101.4000.0c81.903c.60 explicit-path 1 identifier 1
only-explicit
Switch(config-if)# end
Switch#
```

Displaying CES VC Explicit Path Configuration

To display the CES VC explicit path, use the following EXEC command:

Command	Purpose
show running-config [**interface cbr** *card*/*subcard*/*port* [*circuit-id*]]	Displays the CES interface explicit path configuration.

Example

The following example **show running-config** command example shows the soft PVC with an explicit path.

```
Switch# show running-config interface cbr 3/1/0
 no ip address
 ces aal1 service Structured
 ces circuit 6 timeslots 6
 ces circuit 6 shutdown
 ces svc 6 dest-address 47.0091.8100.0000.0010.073c.0101.4000.0c81.903c.60
 ces svc 6 redo-explicit explicit-path 1 identifier 1 only-explicit
 no ces circuit 6 shutdown
Switch#
```

Configuring Point-to-Multipoint CES Soft PVC Connections

This section describes how to configure point-to-multipoint CES soft permanent virtual channel (PVC) connections that provide the following features:

- Connection to multiple hosts or ATM switch routers that support point-to-multipoint soft PVC connections.
- Creation of point-to-multipoint CES soft PVC connections without the complexity of managing large configurations as described in the "Configuring Virtual Channel Connections" section on page 7-2.
- Reroute or retry capabilities when a failure occurs in the network.

Note Point-to-multipoint soft PVP connections are not supported.

Note Route optimization is not supported for point-to-multipoint soft PVCs.

Guidelines for Creating Point-to-Multipoint CES Soft PVCs

Perform the following steps to configure point-to-multipoint CES soft PVCs:

Step 1 Determine whether you want to configure unstructured or structured point-to-multipoint CES soft PVCs.

Step 2 Determine which ports you want to define as participants in the point-to-multipoint CES soft PVC.

Step 3 Decide which of these ports you want to designate as the leaves of the CES soft PVC connection and which of these ports is the root. The leaves of the connection would be the soft PVC destinations and the root would be the source.

Step 4 At the destination switch, retrieve the CES addresses of the destination end of the soft PVC using the **show ces address** command.

Step 5 Configure the source (root) end of the CES soft PVC. At the same time, complete the point-to-multipoint CES soft PVC setup using the information derived from Step 3.

Point-to-multipoint CES soft PVC connections have the following restrictions:

- They can be sourced-from or terminated-on CES interfaces only.
- Dynamic modification of the CTTR (connection traffic table row) on them is not allowed.

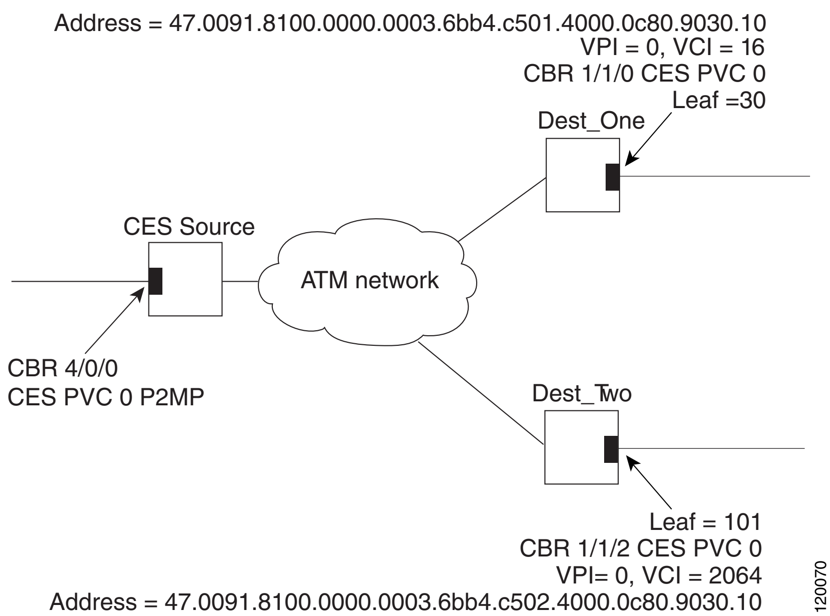
This section describes configuring both unstructured and structured point-to-multipoint CES soft PVC connections and includes the following topics:

- Configuring Point-to-Multipoint Unstructured CES Soft PVCs
- Configuring Point-to-Multipoint Structured CES Soft PVCs

Configuring Point-to-Multipoint Unstructured CES Soft PVCs

Figure 19-10 gives an example of point-to-multipoint unstructured CES soft PVC connections.

Figure 19-10 Point-to-Multipoint Unstructured CES Soft PVC Connection Example



This section describes configuring unstructured point-to-multipoint CES soft PVC connections and includes the following topics:

- Configuring the Destination Side of a Point-to-Multipoint Unstructured CES Soft PVC
- Configuring the Source Side of a Point-to-Multipoint Unstructured CES Soft PVC

Configuring the Destination Side of a Point-to-Multipoint Unstructured CES Soft PVC

To configure the destination side of a point-to-multipoint unstructured CES soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Dest_One# **show ces status**	Displays information about current CBR interfaces. Use this command to choose the destination port.
Step 2	Dest_One# **configure terminal** Dest_One(config)#	Enters configuration mode from the terminal.
Step 3	Dest_One(config)# **interface cbr** *card/subcard/port* Dest_One(config-if)#	Selects the physical interface to configure.
Step 4	Dest_One(config-if)# **shutdown**	Disables the interface.

	Command	Purpose
Step 5	Dest_One(config-if)# **ces aal1 service unstructured**	Configures the service type. The default is **unstructured**.
Step 6	Dest_One(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures CES interface AAL1 clock mode.
Step 7	Dest_One(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Dest_One(config-if)# **ces circuit 0 circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Dest_One(config-if)# **no shutdown**	Reenables the interface.

Note The following configuration example uses the interfaces and addresses displayed in Figure 19-10.

To configure the destination side of the point-to-multipoint unstructured CES connections using the interfaces and addresses in Figure 19-10, follow these steps:

Step 1 At the destination switch for the point-to-multipoint unstructured CES connection, determine which CES interfaces are currently configured in the destination switch router chassis, using the **show ces status** command in privileged EXEC mode.

```
Dest_One# show ces status
   Interface       IF      Admin        Port  Channels in
     Name        Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR1/1/0       UP        UP           T1
```

Step 2 At the destination switch for the point-to-multipoint unstructured CES connection, change to interface configuration mode for CBR interface 1/1/0.

```
Dest_One# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Dest_One(config)# interface cbr 1/1/0
Dest_One(config-if#
```

Step 3 Shut down the interface you want to configure as the destination of the point-to-multipoint unstructured CES connection.

```
Dest_One(config-if)# shutdown
```

Step 4 Configure the destination CES interface AAL1 service type as unstructured.

```
Dest_One(config-if)# ces aal1 service unstructured
```

Step 5 Configure the destination CES interface clock source.

```
Dest_One(config-if)# ces aal1 clock adaptive
```

Step 6 Configure the destination CES interface circuit identifier and circuit name.

```
Dest_One(config-if)# ces circuit 0 circuit-name dest1_unStruct
```

Step 7 Reenable the destination CES interface.

```
Dest_One(config-if)# no shutdown
Switch(config-if)#
```

Next, configure the source side of the point-to-multipoint unstructured CES connection.

Configuring the Source Side of a Point-to-Multipoint Unstructured CES Soft PVC

To configure the source side of a point-to-multipoint unstructured CES soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Dest_One# **show ces addresses**	Determines the destination CES address.
Step 2	Source# **configure terminal** Source(config)#	Enters configuration mode from the terminal.
Step 3	Source(config)# **interface cbr** *card/subcard/port* Source(config-if)#	Selects the CES interface to be configured.
Step 4	Source(config-if)# **ces pvc** *circuit-id* **p2mp** Source(ces-p2mp)#	Specifies the CBR interface circuit identifier and changes to CES point-to-multipoint configuration mode.
Step 5	Source(ces-p2mp)# **party leaf-reference** *ref-number* Source(ces-p2mp-party)#	Configures the point-to-multipoint leaf reference number for each party and changes to point-to-multipoint party configuration mode.
Step 6	Source(ces-p2mp-party)# **dest-address** *ces-address dest-vpi dest-vci*	Configures the destination CES address and destination VPI and destination VCI for each party.

Note The following configuration example uses the interfaces and addresses displayed in Figure 19-10.

To configure the source side of the point-to-multipoint unstructured CES connections using the interfaces and addresses in Figure 19-10, follow these steps:

Step 1 Determine the CES addresses of the Dest_One and Dest_Two destination switches as follows:

For switch Dest_One:

```
Dest_One# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10  CBR1/1/0:0  vpi 0 vci 16

Dest_One#
```

For switch Dest_Two:

```
Dest_Two# show ces address

CES-IWF ATM Address(es):
➔ 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9030.10  CBR1/1/2:0  vpi 0 vci 2064

Dest_Two#
```

Step 2 At the source switch for the point-to-multipoint CES connection, change to interface configuration mode for CBR interface 4/0/0.

```
Source# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface cbr 4/0/0
```

Step 3 Use the **ces pvc** command to configure the source CES soft PVC and change to point-to-multipoint configuration mode.

```
Source(config-if)# ces pvc 0 p2mp
Source(ces-p2mp)#
```

Step 4 Use the **party leaf-reference** command to configure leaf-reference 30 and change to point-to-multipoint party configuration mode.

```
Source(ces-p2mp)# party leaf-reference 30
Source(ces-p2mp-party)#
```

Step 5 Configure the destination ATM address and the VPI and VCI of the destination connection obtained in Step 1.

```
Source(ces-p2mp-party)# dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10 0 16
Source(ces-p2mp-party)# exit
```

Step 6 Use the following similar process to configure the soft PVC connection to the Dest_Two switch:

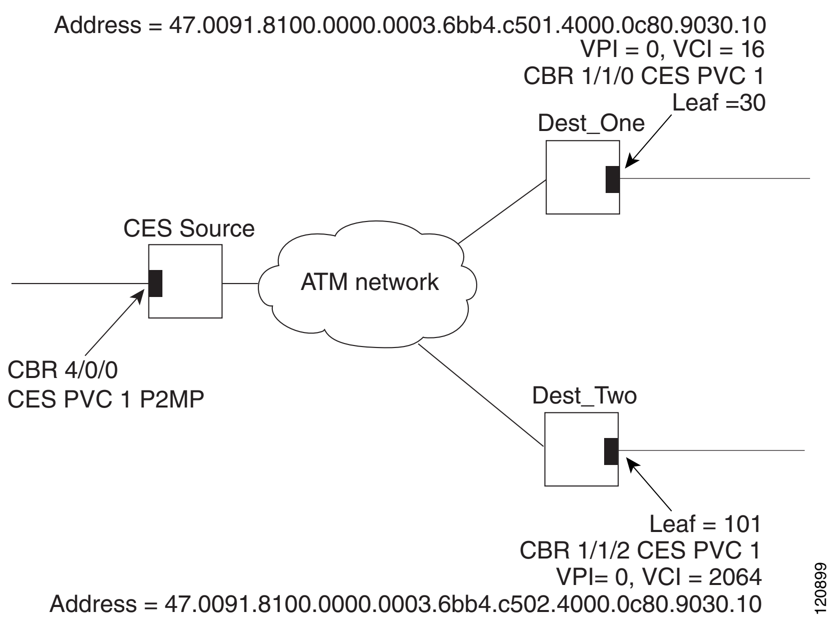
```
Source(ces-p2mp)# party leaf-reference 101
Source(ces-p2mp-party)# dest-address 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9030.10 0 2064
Source(ces-p2mp-party)# end
Source#
```

Step 7 Confirm the connections are up and working using the commands in the "Displaying Point-to-Multipoint CES Soft PVC Configuration" section on page 19-72.

Configuring Point-to-Multipoint Structured CES Soft PVCs

Figure 19-11 gives an example of point-to-multipoint structured CES soft PVC connections.

Figure 19-11 Point-to-Multipoint Structured CES Soft PVC Connection Example



This section describes configuring structured point-to-multipoint CES soft PVC connections and includes the following topics:

- Configuring the Destination Side of a Point-to-Multipoint Structured CES Soft PVC
- Configuring the Source Side of a Point-to-Multipoint Structured CES Soft PVC

Configuring the Destination Side of a Point-to-Multipoint Structured CES Soft PVC

To configure the destination side of a point-to-multipoint structured CES soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Dest_One# **show ces status**	Displays information about current CBR interfaces. Use this command to choose the destination port.
Step 2	Dest_One# **configure terminal** Dest_One(config)#	Enters configuration mode from the terminal.
Step 3	Dest_One(config)# **interface cbr** *card/subcard/port* Dest_One(config-if)#	Selects the physical interface to configure.
Step 4	Dest_One(config-if)# **shutdown**	Disables the interface.

	Command	Purpose
Step 5	Dest_One(config-if)# **ces aal1 service structured**	Configures the service type. The default is **unstructured**.
Step 6	Dest_One(config-if)# **ces aal1 clock** {**adaptive** | **srts** | **synchronous**}	Configures CES interface AAL1 clock mode.
Step 7	Dest_One(config-if)# **ces dsx1 clock source** {**loop-timed** | **network-derived**}	Configures the CES interface clock source.
Step 8	Dest_One(config-if)# **ces circuit** *circuit-id* **circuit-name** *name*	Configures the CES interface circuit identifier and circuit name. **Note** For unstructured service, use 0 for the circuit identifier.
Step 9	Dest_One(config-if)# **no shutdown**	Reenables the interface.

Note The following configuration example uses the interfaces and addresses displayed in Figure 19-11.

To configure the destination side of the point-to-multipoint structured CES connections using the interfaces and addresses in Figure 19-11, follow these steps:

Step 1 At the destination switch for the point-to-multipoint structured CES connection, determine which CES interfaces are currently configured in the destination switch router chassis, using the **show ces status** command in privileged EXEC mode.

```
Dest_One# show ces status
   Interface       IF      Admin        Port  Channels in
     Name        Status   Status        Type      use
------------- -------- --------- ----------- -----------
     CBR1/1/0       UP        UP          T1       1-3, 7
```

Step 2 At the destination switch for the point-to-multipoint structured CES connection, change to interface configuration mode for CBR interface 1/1/0.

```
Dest_One# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Dest_One(config)# interface cbr 1/1/0
Dest_One(config-if#
```

Step 3 Shut down the interface you want to configure as the destination of the point-to-multipoint structured CES connection.

```
Dest_One(config-if)# shutdown
```

Step 4 Configure the destination CES interface AAL1 service type as structured.

```
Dest_One(config-if)# ces aal1 service structured
```

Step 5 Configure the destination CES interface clock source.

```
Dest_One(config-if)# ces aal1 clock adaptive
```

Step 6 Configure the destination CES interface circuit identifier and circuit name.

```
Dest_One(config-if)# ces circuit 1 circuit-name dest1_Struct
```

Step 7 Reenable the destination CES interface.

```
Dest_One(config-if)# no shutdown
Dest_One(config-if)#
```

Now you can configure the source side of the point-to-multipoint structured CES connection.

Configuring the Source Side of a Point-to-Multipoint Structured CES Soft PVC

To configure the source side of a point-to-multipoint structured CES soft PVC connection, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Dest_One# **show ces addresses**	Determines the destination CES address.
Step 2	Source# **configure terminal** Source(config)#	Enters configuration mode from the terminal.
Step 3	Source(config)# **interface cbr** *card/subcard/port* Source(config-if)#	Selects the CES interface to be configured.
Step 4	Source(config-if)# **ces pvc** *circuit-id* **p2mp** Source(ces-p2mp)#	Specifies the CBR interface circuit identifier and changes to CES point-to-multipoint configuration mode.
Step 5	Source(ces-p2mp)# **party leaf-reference** *ref-number* Source(ces-p2mp-party)#	Configures the point-to-multipoint leaf reference number for each party and changes to point-to-multipoint party configuration mode.
Step 6	Source(ces-p2mp-party)# **dest-address** *ces-address dest-vpi dest-vci*	Configures the destination CES address and destination VPI and destination VCI for each party.

Note The following configuration example uses the interfaces and addresses displayed in Figure 19-11.

To configure the source side of the point-to-multipoint structured CES connections using the interfaces and addresses in Figure 19-11, follow these steps:

Step 1 Determine the CES addresses of the Dest_One and Dest_Two destination switches as follows:

For switch Dest_One:

```
Dest_One# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10  CBR1/1/0:1   vpi 0 vci 16

Dest_One#
```

For switch Dest_Two:

```
Dest_Two# show ces address

CES-IWF ATM Address(es):
47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9030.10  CBR1/1/2:1   vpi 0 vci 2064

Dest_Two#
```

Step 2 At the source switch for the point-to-multipoint CES connection, change to interface configuration mode for CBR interface 4/0/0.

```
Source# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface cbr 4/0/0
```

Step 3 Use the **ces pvc** command to configure the source CES soft PVC and change to point-to-multipoint configuration mode.

```
Source(config-if)# ces pvc 1 p2mp
Source(ces-p2mp)#
```

Step 4 Use the **party leaf-reference** command to configure leaf-reference 30 and change to point-to-multipoint party configuration mode.

```
Source(ces-p2mp)# party leaf-reference 30
Source(ces-p2mp-party)#
```

Step 5 Configure the destination ATM address and the VPI and VCI of the destination connection obtained in Step 1.

```
Source(ces-p2mp-party)# dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10 0 16
Source(ces-p2mp-party)# exit
```

Step 6 Use the following similar process to configure the soft PVC connection to the Dest_Two switch:

```
Source(ces-p2mp)# party leaf-reference 101
Source(ces-p2mp-party)# dest-address 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9030.10 0 2064
Source(ces-p2mp-party)# end
Source#
```

Step 7 Confirm the connections are up and working using the commands in the "Displaying Point-to-Multipoint CES Soft PVC Configuration" section on page 19-72.

Displaying Point-to-Multipoint CES Soft PVC Configuration

To display the point-to-multipoint CES soft PVC configuration at either end of an ATM switch router, use the following EXEC commands:

Command	Purpose
show running-config interfaces cbr *card/subcard/port*	Shows the configuration of the CES interface.
show ces circuit interface cbr *card/subcard/port circuit-id*	Shows point-to-multipoint CES soft PVC interface configuration.

Examples

The following example shows the point-to-multipoint CES soft PVC configuration of the source switch on interface CBR 4/0/0 using the **show running-config** command:

```
Source# show running-config interface cbr 4/0/0
Building configuration...

Current configuration : 273 bytes
!
interface CBR4/0/0
 no ip address
 ces circuit 0
 ces pvc 0  p2mp
  party leaf-reference 30
  dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10 0 16
  party leaf-reference 101
  dest-address 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9038.10 0 2064
end
```

The following example shows the point-to-multipoint CES soft PVC configuration of the source switch on interface CBR 4/0/0 using the **show ces circuit interface cbr** command:

```
Source# show ces circuit interface cbr 4/0/0 0
Circuit: Name CBR4/0/0:0, Circuit-state ADMIN_UP / oper-state UP Interface CBR4/0/0,
Circuit_id 0, Port-Type E1-120ohms, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-31
Channels used by this circuit: 1-31
Cell-Rate: 5447, Bit-Rate 2048000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow 0, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 0
P2MP-SoftVC
Src: atm addr 47.0091.8100.0000.0060.83c5.2e01.4000.0c82.0030.10 vpi 0, vci 16
Circuit Type is P2MP:

 Leaf Reference 30
 Remote ATM address: 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10
 Remote VPI: 0
 Remote VCI: 16
 Party Soft-Vc State Active
 Leaf Reference 101
 Remote ATM address: 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9038.10
 Remote VPI: 0
 Remote VCI: 2064
 Party Soft-Vc State Active
Source#
```

Deleting and Disabling Point-to-Multipoint CES Soft PVC Connections

This section describes the process used to delete all or part of a CES point-to-multipoint soft PVC connection. This section also describes how to either enable or disable a point-to-multipoint CES soft PVC connection.

Deleting Point-to-Multipoint CES Soft PVC

This section describes the process used to delete either the entire CES point-to-multipoint soft PVC connection or delete a specific leaf of the connection from the connection.

To remove the entire CES point-to-multipoint soft PVC connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the CES interface to be configured.
Step 2	Switch(config-if)# **no ces pvc** *circuit-id* **p2mp**	Deletes the CES point-to-multipoint soft PVC.

To delete a specific leaf of the CES point-to-multipoint soft PVC connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface cbr** *card/subcard/port* Switch(config-if)#	Selects the CES interface to be configured.
Step 2	Switch(config-if)# **ces pvc** *circuit-id* **p2mp** Switch(ces-p2mp)#	Specifies the CBR interface circuit identifier and changes to CES point-to-multipoint configuration mode.
Step 3	Switch(ces-p2mp)# **no party leaf-reference** *ref-number*	Deletes a specific CES point-to-multipoint leaf using the reference number.

Examples

The following example shows how to remove the entire point-to-multipoint CES soft PVC connection configured on the CBR interface 4/0/0 for CES circuit 0:

```
Source(config)# interface cbr 4/0/0
Source(config)# no ces circuit 0
```

The following example shows how to remove only party leaf 1 on the CES soft PVC connection configured on the point-to-multipoint CES PVC 0:

```
Source(config)# interface cbr 4/0/0
Source(config-if)# ces pvc 0 p2mp
Source(ces-p2mp)# no party leaf-reference 30
```

Confirming VCC Deletion

To confirm the deletion of the point-to-multipoint soft PVC from an interface, use the following EXEC command before and after deleting the point-to-multipoint soft PVC:

Command	Purpose
show ces circuit interface cbr *card/subcard/port*	Shows point-to-multipoint CES soft PVC interface status.

Example

The following example shows how to confirm the entire point-to-multipoint soft PVC circuit is deleted from the interface:

```
Source# show ces circuit interface cbr 4/0/1

Source#
```

If the point-to-multipoint CES soft PVC circuit does not exist the display appears empty.

The following example shows how to confirm the point-to-multipoint CES soft PVC circuit is configured:

```
Source# show ces circuit interface cbr 4/0/0
Interface  Circuit  Circuit-Type     X-interface   X-vpi   X-vci Status
 CBR4/0/0    0       P2MP-SoftVC P2MP-SoftVc    ATM1/0/1      0        35  UP

Source#
```

Enabling and Disabling the Root of a Point-to-Multipoint CES Soft PVC

To enable or disable the root of a point-to-multipoint CES soft PVC connection, perform the following steps, beginning in CES soft PVC point-to-multipoint configuration mode:

	Command	Purpose
Step 1	Switch(ces-p2mp)# **disable**	Disables a point-to-multipoint CES soft PVC connection and releases all parties.
Step 2	Switch(ces-p2mp)# **enable**	Enables a point-to-multipoint CES soft PVC connection.

Note The **disable** option releases all the parties of the connection, and the CES soft PVC connection appears in the NOT_CONNECTED state. No retry will occur until you enable the CES soft PVC using the **enable** option.

Examples

The following example disables the point-to-multipoint CES soft PVC connection configured on CBR interface 4/0/0 and releases all parties:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface cbr 4/0/0
```

```
Switch(config-if)# ces pvc 0 p2mp
Switch (ces-p2mp)# disable
04:47:14: %SYS-5-CONFIG_I: Configured from console by console
04:47:15: %LINK-3-UPDOWN: Interface CBR4/0/0, changed state to down
Switch (ces-p2mp)#
```

The following example reenables the point-to-multipoint CES soft PVC connection:

```
Switch (ces-p2mp)# enable
Switch (ces-p2mp)#
```

Enabling and Disabling a Leaf of a Point-to-Multipoint CES Soft PVC

To enable or disable an individual leaf of a point-to-multipoint CES soft PVC connection, perform the following steps, beginning in CES soft PVC point-to-multipoint configuration mode:

	Command	Purpose
Step 1	Switch(ces-p2mp)# **party leaf-reference** *ref-number* **disable** Switch(ces-p2mp-party)#	Disables a leaf of a point-to-multipoint CES soft PVC connection.
Step 2	Switch(ces-p2mp)# **party leaf-reference** *ref-number* **enable**	Enables a leaf of a point-to-multipoint CES soft PVC connection.

Examples

The following example disables an individual leaf-reference 30 of a point-to-multipoint CES soft PVC connection configured on a CBR interface:

```
Source# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Source(config)# interface cbr 4/0/0
Source(config-if)# ces pvc 0 p2mp
➔ Source(ces-p2mp)# party leaf-reference 30 disable
Source(ces-p2mp-party)#
```

Note After disabling a party leaf the CLI changes from CES point-to-multipoint configuration mode to CES point-to-multipoint party configuration mode. This allows you to modify the party configuration and exit out of the party mode and enable the party leaf again with the modified configurations. For example, you can modify the retry interval, destination address, destination VPI and destination VCI.

The following example reenables an individual leaf of the point-to-multipoint CES soft PVC connection:

```
Source (ces-p2mp)# party leaf-reference 30 enable
Source (ces-p2mp)#
```

Confirming the Party Leaf is Disabled or Enabled

To confirm the individual leaf of the CES point-to-multipoint soft PVC is disabled or enabled, use the following EXEC commands before and after disabling and enabling the CES point-to-multipoint soft PVC:

Command	Purpose
show running-config interface cbr *card/subcard/port*	Shows the configuration of the CBR interfaces.
show ces circuit interfaces cbr *card/subcard/port circuit-id*	Shows the point-to-multipoint CES soft PVCs configured on the interface.

Example

The following example shows how to confirm that the party leaf of the CES point-to-multipoint soft PVC is disabled from the interface using the **show running-config** command:

```
Source# show running-config interface cbr 4/0/0
Building configuration...

Current configuration : 280 bytes
!
interface CBR4/0/0
 no ip address
 ces circuit 0
 ces pvc 0  p2mp
➔  party leaf-reference 30 disable
  dest-address 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10 0 16
  party leaf-reference 101
  dest-address 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9038.10 0 2064
end
```

Notice the word “disabled” appears following the party leaf-reference number for party leaf-reference 30 disabled in the previous section.

Note The word “enabled” does not appears following the party leaf-reference number for party leaf-reference 101 that was not disabled. Enabled is the default state.

The following example shows how to confirm that the party leaf of the CES point-to-multipoint soft PVC is disabled from the interface using the **show ces circuit interface cbr** command:

```
Source# show ces circuit interface cbr 4/0/0 0
Circuit: Name CBR4/0/0:0, Circuit-state ADMIN_UP / oper-state UP Interface CBR4/0/0,
Circuit_id 0, Port-Type E1-120ohms, Port-State UP
Port Clocking network-derived, aal1 Clocking Method CESIWF_AAL1_CLOCK_SYNC
Channel in use on this port: 1-31
Channels used by this circuit: 1-31
Cell-Rate: 5447, Bit-Rate 2048000
cas OFF, cell_header 0x100 (vci = 16)
Configured CDV 2000 usecs, Measured CDV unavailable
De-jitter: UnderFlow 0, OverFlow 0
ErrTolerance 8, idleCircuitdetect OFF, onHookIdleCode 0x0
state: VcAlarm, maxQueueDepth      823, startDequeueDepth      435
Partial Fill:       47, Structured Data Transfer 0
P2MP-SoftVC ,Setup in progress
Src: atm addr 47.0091.8100.0000.0060.83c5.2e01.4000.0c82.0030.10 vpi 0, vci 16
Circuit Type is P2MP:

 Leaf Reference 30
 Remote ATM address: 47.0091.8100.0000.0003.6bb4.c501.4000.0c80.9030.10
 Remote VPI: 0
 Remote VCI: 16
➔ Party Soft-Vc State Inactive
```

```
 Leaf Reference 101
 Remote ATM address: 47.0091.8100.0000.0003.6bb4.c502.4000.0c80.9038.10
 Remote VPI: 0
 Remote VCI: 2064
➔ Party Soft-Vc State Active
```

The word "Inactive" appears after the Party Soft-Vc State field for leaf-reference 30 disable in the previous section. In contrast, the word "Active" appears after the Party Soft-Vc State field for leaf-reference 101 that was not changed.

Configuring the Retry Interval for Point-to-Multipoint CES Soft-PVC Parties

To configure the first and maximum retry intervals for each party of a point-to-multipoint CES soft PVC connection, perform the following steps, beginning in CES soft PVC party configuration mode:

Command	Purpose
Switch(ces-p2mp-party)# **retry-interval first** {**100-3600000**} **maximum** {**100-4294967295**}	Configures the first and maximum retry intervals in milliseconds on a point-to-multipoint CES soft PVC connection.

Examples

The following example configures the first and maximum retry intervals for each party of a point-to-multipoint CES soft PVC connection configured on a CBR interface:

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface cbr 4/0/0
Switch(config-if)# ces pvc 0 p2mp
Switch(ces-p2mp)# party leaf-reference 30
Switch(ces-p2mp-party)# retry-interval first 200 maximum 300
```

CHAPTER 20

Configuring Frame Relay to ATM Interworking Port Adapter Interfaces

This chapter describes Frame Relay to ATM interworking and the required steps to configure the channelized Frame Relay port adapters in the Catalyst 8510 MSR and LightStream 1010 ATM switch routers. These port adapters facilitate interworking between a Frame Relay network, an ATM network, and network users. Existing Frame Relay users can also migrate to higher bandwidth ATM using channelized Frame Relay port adapters. Additionally, these port adapters extend the ATM network across a wide area over a frame-based serial line or intervening Frame Relay WAN.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For an overview of Frame Relay to ATM interworking, refer to the *Guide to ATM Technology*. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For hardware installation and cabling instructions, refer to the *ATM and Layer 3 Port Adapter and Interface Module Installation Guide*.

For a more information on how to configure your Frame Relay specific network equipment, refer to the Cisco IOS 11.3 publications on the Documentation CD-ROM.

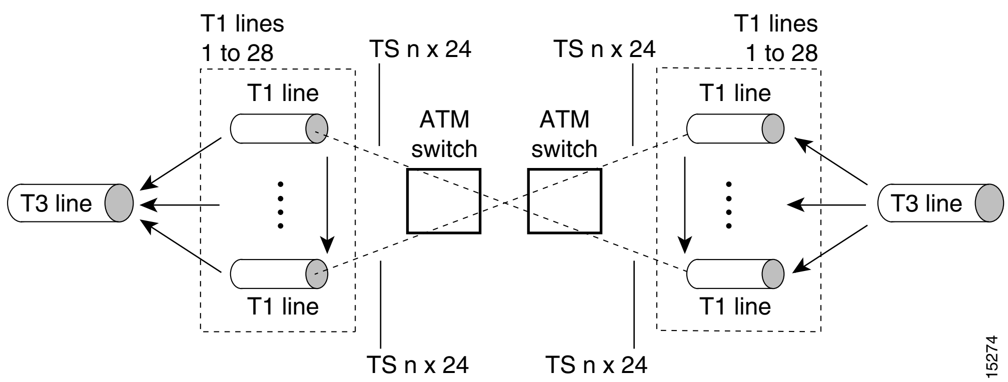
This chapter includes the following sections:

Configuring the Channelized DS3 Frame Relay Port Adapter

The channelized DS3 (CDS3) Frame Relay port adapter provides one physical port (45 Mbps). Each DS3 interface consists of 28 T1 lines multiplexed through a single T3 trunk. Each T1 line operates at 1.544 Mbps, which equates to 24 time slots (DS0 channels). A DS0 time slot provides 56 or 64 kbps of usable bandwidth. You can combine one or more DS0 time slots into a channel group to form a serial interface. A channel group provides *n* x 56 or 64 kbps of usable bandwidth, where *n* is the number of time slots, from 1 to 24. You can configure a maximum of 127 serial interfaces, or channel groups, per port adapter.

Figure 20-1 illustrates how a T3 trunk demultiplexes into 28 T1 lines that provide single or multiple time slots mapped across the ATM network. These time slots are then multiplexed to form an outgoing T3 bit stream.

Figure 20-1 T3/T1 Time Slot Mapping



Configuration Guidelines

In order to configure the CDS3 Frame Relay port adapter physical interface you need the following information:

- Digital transmission link information, for example, T3 and T1 clock source and framing type
- Channel information and time slot mapping
- Protocols and encapsulations you plan to use on the new interfaces

Default CDS3 Frame Relay Port Adapter Interface Configuration

The following defaults are assigned to all CDS3 Frame Relay port adapter interfaces:

- Framing—M23
- Clock source—loop-timed
- Cable length—224

The following defaults are assigned to all T1 lines on the CDS3 Frame Relay port adapter:

- Framing— esf
- Speed—64 kbps

- Clock source—internal
- Line coding—b8zs
- T1 yellow alarm—detection and generation

Configuring the CDS3 Frame Relay Port Adapter Interface

To manually change any of your default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller t3** *card*/*subcard*/*port* Switch(config-controller)#	Specifies the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **clock source** {**free-running** | **loop-timed** | **network-derived** | **reference**}	Configures the type of clocking.
Step 3	Switch(config-controller)# **framing** {**c-bit** | **m23**}	Configures the CDS3 Frame Relay port adapter framing type.
Step 4	Switch(config-controller)# **cablelength** *cablelength*	Configures the CDS3 Frame Relay port adapter cable length.
Step 5	Switch(config-controller)# **mdl** {**transmit** {**path** | **idle-signal** | **test-signal**} | **string** {**eic** | **lic** | **fic** | **unit** | **pfi** | **port** | **generator** *string*}[1]	Configures the maintenance data link (MDL) message.

1. MDL messages are only supported when framing on the CDS3 Frame Relay port adapter is set for c-bit parity.

Example

The following example shows how to change the cable length configuration to 300 using the **cablelength** command.

```
Switch(config)# controller t3 3/0/0
Switch(config-controller)# cablelength 300
```

When using the cable length option, note that user-specified T3 cable lengths are structured into ranges as follows: 0 to 224 and 225 to 450. If you enter a cable length value that falls into one of these ranges, the range for that value is used.

For example, if you enter 150 feet, the 0 to 224 range is used. If you later change the cable length to 200 feet, there is no change because 200 is within the 0 to 224 range. However, if you change the cable length to 250, the 225 to 450 range is used. The actual number you enter is stored in the configuration file.

Configuring the T1 Lines on the CDS3 Frame Relay Port Adapter

To configure the T1 lines, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller t3** *card/subcard/port* Switch(config-controller)#	Specifies the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **t1** *line-number* **framing** {**esf** | **sf**}	Configures the T1 framing type.
Step 3	Switch(config-controller)# **t1** *line-number* **yellow** {**detection** | **generation**}	Configures yellow alarms for the T1 line.

Configuring the Channel Group on the CDS3 Frame Relay Port Adapter

A channel group, also referred to as a serial interface, is configured on a T1 line by associating time slots to it. The channel group can have from 1 to 24 time slots (DS0s). The transmission rate or bandwidth of the channel group is calculated by multiplying the number of time slots times 56 kbps or 64 kbps.

Note A time slot can be part of only one channel group. Additionally, all time slots within a channel group must be on the same T1 line.

To configure the channel group on a T1 line, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller t3** *card/subcard/port*	Specifies the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **channel-group** *number* **t1** *line-number* **timeslots** *list* [**speed** {**56** | **64**}]	Creates the channel group with the specified time slots and speed.

Note You can group either contiguous or noncontiguous time slots on a T1 line.

Example

The following example shows how to configure a channel group (with identifier 5), assigning time slots 1 through 5 on T1 line 1 using the **channel-group** command.

```
Switch(config)# controller t3 0/1/0
Switch(config-controller)# channel-group 5 t1 1 timeslots 1-5
Switch(config-controller)#
```

Note The example above creates the serial interface 0/1/0:5.

Displaying the CDS3 Frame Relay Port Adapter Controller Information

To display the controller configuration, use one of the following EXEC commands:

Command	Purpose
show controllers t3 *card***/***subcard***/***port*[**:***t1-line*] [**brief** | **tabular**]	Displays T3 and T1 configuration.

Example

The following example displays the configuration, status, and statistics of T1 line number 1 on controller 0/1/0:

```
Switch# show controllers t3 0/1/0:1 tabular
➔ T3 0/1/0:1 is up.
   PAM state is Up
   1CT3 H/W Version: 1.7
   1CT3 F/W Version: 2.7
➔ T3 0/1/0 T1 1
    Transmitter is sending LOF Indication (RAI).
    Receiver has loss of frame.
    Framing is ESF, Line Code is B8ZS, Clock Source is line.
    INTERVAL      LCV   PCV   CSS  SELS   LES    DM    ES   BES   SES   UAS    SS
    12:43-12:51     0     0     0     0     0     0     0     0     0   434     0
    12:28-12:43     0     0     0     0     0     0     0     0     0   900     0
    12:13-12:28     0     0     0     0     0     0     0     0     0   900     0
    11:58-12:13     0     0     0     0     0     0     0     0     0   900     0
    11:43-11:58     0     0     0     0     0     0     0     0     0   900     0
    11:28-11:43     0     0     0     0     0     0     0     0     0   900     0
    11:13-11:28     0     0     0     0     0     0     0     0     0   900     0
    10:58-11:13     0     0     0     0     0     0     0     0     0   900     0
    Total           0     0     0     0     0     0     0     0     0  6300     0
```

Deleting a Channel Group on the CDS3

This section describes two ways to delete a channel group on the CDS3 after it has been configured.

If you want to delete individual channel groups without shutting down the controller, use method one.

If you want to delete several channels groups on a controller, use method two. However, if you use method two, you must first shut down the controller, which shuts down all channel groups on the controller.

Method One

Perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn*	Selects the Frame Relay serial port and channel group number to be deleted.
Step 2	Switch(config-if)# **shutdown**	Shuts down the serial interface.

	Command	Purpose
Step 3	Switch(config-if)# **exit** Switch(config)#	Exits serial interface configuration mode.
Step 4	Switch(config)# **controller t3** *card*/*subcard*/*port* Switch(config-controller)#	Selects the controller interface port and enters controller configuration mode.
Step 5	Switch(config-controller)# **no channel-group** *cgn*	Deletes the selected channel group number.

Method Two

Perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller t3** *card*/*subcard*/*port* Switch(config-controller)#	Selects the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **shutdown**	Shuts down the controller interface.
Step 3	Switch(config-controller)# **no channel-group** *cgn*	Deletes the selected channel group number.
Step 4	Switch(config-controller)# **no shutdown**	Reenables the controller interface.

Examples

The following example shuts down the serial interface and deletes channel group 1:

```
Switch(config)# interface serial 4/0/0:1
Switch(config-if)# shutdown
Switch(config-if)# exit
Switch(config)# controller t3 4/0/0
Switch(config-controller)# no channel-group 1
Switch(config-controller)# end
Switch#
```

The following example shuts down the T3 controller, deletes channel group 1, and then reenables the T3 controller:

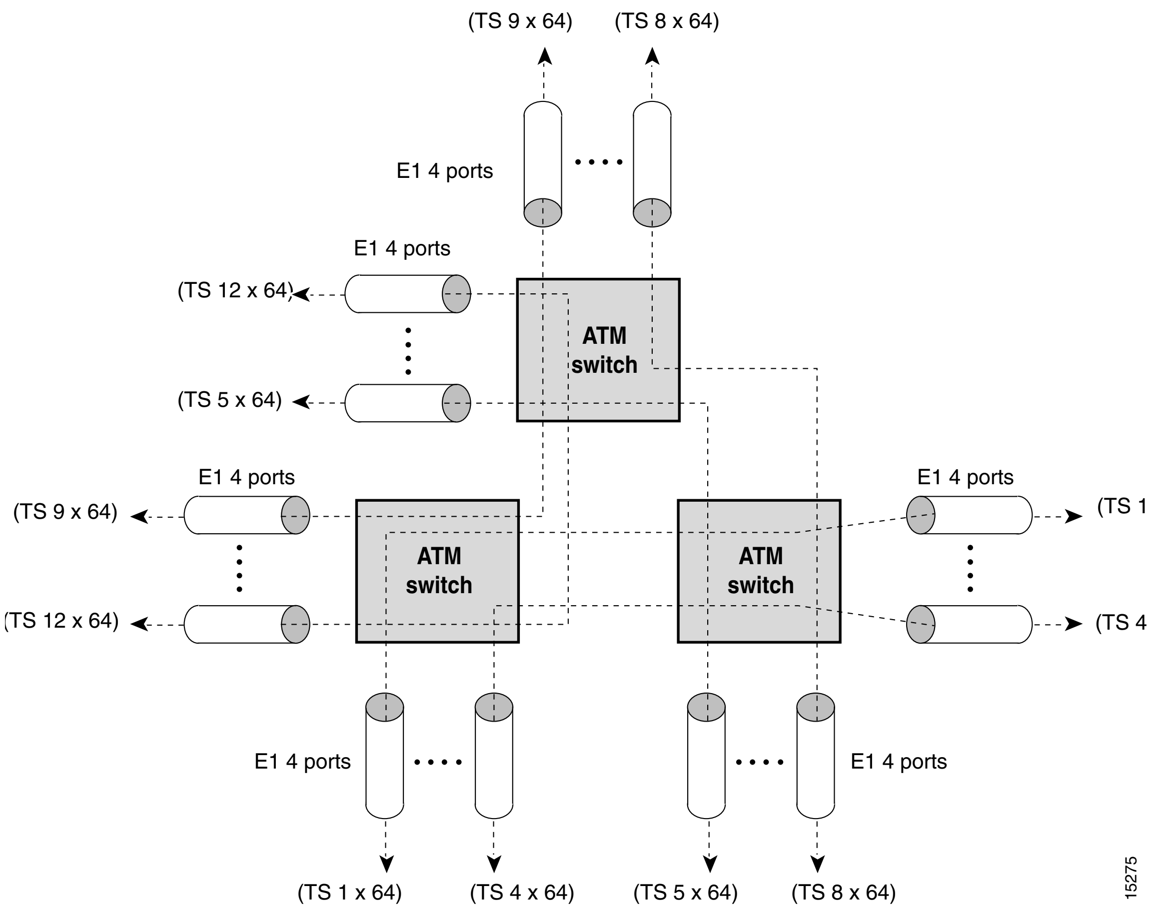
```
Switch(config)# controller t3 4/0/0
Switch(config-controller)# shutdown
Switch(config-controller)# no channel-group 1
Switch(config-controller)# no shutdown
Switch(config-controller)# end
Switch#
```

Configuring the Channelized E1 Frame Relay Port Adapter

The channelized E1 (CE1) Frame Relay port adapter provides four physical ports. Each port supports up to 31 E1 serial interfaces, also referred to as channel groups, totalling 124 serial interfaces per port adapter. The E1 line operates at 2.048 Mbps, which is equivalent to 31 time slots (DS0 channels). The E1 time slot provides usable bandwidth of *n* x 64 kbps, where *n* is the time slot from 1 to 31.

Figure 20-2 illustrates how an E1 trunk (with four ports) provides single or multiple time slots mapped across the ATM network. Each time slot represents a single *n* x 64 circuit that transmits data at a rate of 64 kbps. Multiple *n* x 64 circuits can be connected to a single port, using separate time slots.

Figure 20-2 E1 Time Slot Mapping



Default CE1 Frame Relay Port Adapter Interface Configuration

The following defaults are assigned to all CE1 Frame Relay port adapter interfaces:

- Framing—crc4
- Clock source—loop-timed
- Line coding—HDB3

Configuring the CE1 Frame Relay Port Adapter Interface

If your CE1 Frame Relay port adapter needs to be configured, you must have the following information:

- Digital transmission link information, for example, E1 clock source and framing type
- Channel information and time slot mapping
- Protocols and encapsulations you plan to use on the new interfaces

To manually change any of your default configuration values, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller e1** *card*/*subcard*/*port* Switch(config-controller)#	Specifies the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **clock source** {**free-running** | **loop-timed** | **reference** | **network-derived**}	Configures the type of clocking.
Step 3	Switch(config-controller)# **framing** {**crc4** | **no-crc4**}	Configures the E1 framing type.

Example

The following example shows how to change the clock source to free-running using the **clock source** command.

```
Switch(config)# controller e1 1/0/0
Switch(config-controller)# clock source free-running
```

Configuring the Channel Group on the CE1 Frame Relay Port Adapter

A channel group, also referred to as a serial interface, is configured on an E1 line by associating time slots to it. The channel group can have from 1 to 31 time slots (DS0s). The transmission rate or bandwidth of the channel group is calculated by multiplying the number of time slots times 64 kbps.

To configure the channel group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **controller e1** *card*/*subcard*/*port* Switch(config-controller)#	Specifies the controller interface port and enters controller configuration mode.
Step 2	Switch(config-controller)# **channel-group** *number* {**timeslots** *range* | **unframed**}	Configures the identifier and range of E1 time slot number(s) that comprise the channel group. The keyword **unframed** configures a CE1Frame Relay interface as clear channel (unframed).

Example

The following example shows how to configure time slots 1 through 5 and 20 through 23 on E1 channel group 5 using the **channel-group** command.

```
Switch(config)# controller e1 0/1/0
Switch(config-controller)# channel-group 5 timeslots 1-5, 20-23
```

Displaying the CE1 Frame Relay Port Adapter Controller Information

To display your controller configuration, use the following EXEC command:

Command	Purpose
show controllers e1 *card/subcard/port* [**brief** | **tabular**]	Displays E1 controller configuration.

Example

The configuration for controller E1 is displayed in the following example:

```
Switch# show controllers e1 0/0/0 tabular
E1 0/0/0 is up.
E1 0/0/0 is up.
 PAM state is Up
 4CE1 H/W Version: 3.1
  4CE1 F/W Version: 2.0
  No alarms detected.
  Framing is crc4, Line Code is HDB3, Clock Source is line.
  INTERVAL       LCV  PCV  CS  SELS LES  DM   ES  BES  SES  UAS  SS
  18:38-18:51     0    0    0    0    0    0    2    0   10  704   0
```

Configuring Frame Relay to ATM Interworking Functions

You must follow the required steps to enable Frame Relay to ATM interworking on your ATM switch router. In addition, you can customize Frame Relay to ATM for your particular network needs and monitor Frame Relay to ATM connections. The following sections outline these tasks:

- Enabling Frame Relay Encapsulation on an Interface, page 20-9
- Configuring Frame Relay Serial Interface Type, page 20-10

For information on how to customize your Frame Relay to ATM connections, see Configuring LMI, page 20-14 and Configuring Frame Relay to ATM Resource Management, page 20-18.

Enabling Frame Relay Encapsulation on an Interface

To set Frame Relay encapsulation on the serial interface, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card/subcard/port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **encapsulation frame-relay ietf**	Configures Frame Relay encapsulation.

Frame Relay supports encapsulation of all supported protocols in conformance with RFC 1490, allowing interoperability between multiple vendors.

Note You must shut down the interface prior to Frame Relay encapsulation.

Example

```
Switch(config)# interface serial 0/1/0:5
Switch(config-if)# shutdown
Switch(config-if)# encapsulation frame-relay ietf
Switch(config-if)# no shutdown
```

Displaying Frame Relay Encapsulation

To display Frame Relay encapsulation, use the following user EXEC command:

Command	Purpose
show interfaces serial *card***/***subcard***/***port***:***cgn*	Displays Frame Relay encapsulation.

Example:

The following example displays the Frame Relay encapsulation configuration on serial interface 0/1/0:5:

```
Switch# show interfaces serial 0/1/0:5
Serial0/1/0:5 is up, line protocol is up
  Hardware is FRPAM-SERIAL
  MTU 4096 bytes, BW 320 Kbit, DLY 0 usec, rely 0/255, load 1/255
Encapsulation FRAME-RELAY IETF, loopback not set, keepalive not set
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops:
<information deleted>
```

Configuring Frame Relay Serial Interface Type

To configure an interface as a data communications equipment (DCE) or Network-Network Interface (NNI) type, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay intf-type** {**dce** | **nni**}	Selects a Frame Relay interface type.

Example

The following example shows how to configure Frame Relay interface type NNI for serial interface 0/1/0:5:

```
Switch(config)# interface serial 0/1/0:5
Switch(config-if)# frame-relay intf-type nni
```

Displaying Frame Relay Interface Configuration

To display the Frame Relay interface configuration, use the following EXEC command:

Command	Purpose
more system:running-config	Displays the Frame Relay interface configuration.

Example

The Frame Relay configuration is displayed in the following example:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version 11.3
no service pad
no service password-encryption
!
hostname Switch
!
<information deleted>
!
interface Serial0/1/0:5
 no ip address
 no ip directed-broadcast
 encapsulation frame-relay IETF
 no arp frame-relay
➔ frame-relay intf-type nni
<information deleted>
```

Configuring Frame Relay Frame Size for Frame Relay to ATM Interworking

Frame Relay frame size is one of the parameters in IWF equations used for converting Frame Relay traffic parameters to their equivalent ATM traffic parameters and vice-versa. The default configuration uses a constant frame size of 250 bytes in the IWF equations. For some Frame Relay network configurations this could cause problems such as:

- Frames being dropped if actual frame size is less than 250 bytes
- Wasted bandwidth if actual frame size is greater than 250 bytes

To overcome this problem you can configure the Frame Relay frame size.

If the incoming traffic is always a single frame length, then configure that frame size in the connection traffic table row (CTTR). However, if the incoming traffic has a varying frame-size, then configure the Frame Relay CTTR using the highest sustained cell rate (SCR) for a given committed information rate (CIR) in the corresponding ATM-CTTR. Refer to the section Configuring Frame Relay to ATM Connection Traffic Table Rows.

Note Usually the Frame Relay CTTR with the lowest frame size has the highest SCR for a given CIR. This is because of the overhead introduced by ATM [5 bytes/Cell + 8 Bytes for the AAL5 trailer + AAL5 Padding].

There are exceptional cases when the padding is greater. For example, in the case of 85 byte and 87 byte frame-sizes, the convention of lower size does not hold true because of the additional padding added to an AAL5 in case of 87 byte to 85 byte frame-sizes. In this case, the 87 byte frame-size should be used because it has the higher SCR.

The *easiest* way to choose which frame-size to configure is to use the one with *highest* SCR for the corresponding CIR. For example, if you have frames sizes 64, 90, 250, 512 1500, and 4000, the best SCR for the frames is the size 90 for a given CIR. If frame-size 50 is added to the previous list of frame sizes then CTTR with 50 will have the highest SCR and that should be used.

Configuring and Using Frame Relay Frame Size

To use the Frame Relay frame size feature, requires the following:

- Create a Traffic table row (CTTR) using frame size
- Use that CTTR row while creating a VC (PVC or Soft PVC)

To configure the Frame Relay frame size, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **frame-relay connection-traffic table-row** [**index** *row-index*] *cirval bcval pirval* [*beval*] {**abr** | **vbr-nrt** | **ubr**} [**frame-size** *bytes*] [*atm-row-index*]	Configures the frame size used to convert Frame Relay traffic parameters to their equivalent ATM traffic parameters.
Step 2	Switch(config)# **interface serial** *card*/*subcard*/*port*:*cgn*	Select the interface to configure.
Step 3	Switch(config-if)# **frame-relay soft-vc** *dlci_source* **dest-address** *address dlci_destinataion* **rx-cttr** *index* **tx-cttr** *index* **gat**	Configure the Frame Relay Soft VC and enable GAT solution on the VC.
Step 4	Switch(config-if)# **end** Switch#	Exits serial interface configuration mode.
Step 5	Switch# **show frame-relay connection-traffic table** *row*	Confirm the Frame Relay CTT has the frame size value configured.
Step 6	Switch# **show vc interface serial** *card*/*subcard*/*port*:*cgn dlci*	Confirm the configured frame size is used in the serial interface VC.
Step 7	Switch# **show running-config interface serial** *card*/*subcard*/*port*:*cgn*	Confirm GAT is enabled in the serial interface VC.

Use the following steps to configure Frame Relay frame size of an interworking soft PVC.

Step 1 Configure the Frame Relay frame size as part of the CTT row configuration.

```
Switch(config)# frame-relay connection-traffic-table-row 102 16000 32768 6400 vbr-nrt
frame-size 64
```

Step 2 Select which interface to configure.

```
Switch(config)# interface Serial1/0/1:1
Switch(config-if)#
```

Step 3 Configure the Frame Relay Soft VC and enable GAT.

```
Switch(config-if)# frame-relay soft-vc 128 dest-address
47.0091.8100.0000.0090.2156.d801.4000.0c80.1010.00 dlci 43 rx-cttr 102 tx-cttr 102 gat
Switch(config-if)# end
Switch#
```

Note By default, the GAT information element is disabled. To use the frame size feature you must enable GAT on the VC.

Step 4 Display the frame size in the CTT row configuration using the **show frame-relay connection-traffic-table-row** command.

```
Switch# show frame-relay connection-traffic-table-row
Row          cir      bc      be       pir     FrameSize   fr-atm        ATM Row
                                                     Service-category
102         16000   32768   32768   6400       64         vbr            100

Switch#
```

Step 5 Confirm the frame size is configured for the VC using the **show vc interface serial** command.

```
Switch# show vc interface serial 1/0/1:1 128

Interface: Serial1/0/1:1, Type: FRPAM-SERIAL
DLCI = 128 Status : ACTIVE   Peer Status : INACTIVE
Connection-type: PVC
Cast-type: point-to-point
Per VC Overflow: Disabled
Configured Option is: Inherit from Interface.
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 4d21h Time-since-last-status-change : 4d21h
Interworking Function Type : service translation
de-bit Mapping : map-clp       clp-bit Mapping : map-de
efci-bit Mapping : 0
ATM-P Interface: ATM-P1/0/0, Type: ATM-PSEUDO
ATM-P VPI = 33  ATM-P VCI = 75
ATM-P Connection Status: UP
Cross-connect-interface: ATM4/0/0, Type: arm_port
Cross-connect-VPI = 2
Cross-connect-VCI = 128
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Cross-connect-UPC: pass
Transmit Direction :
        Total tx Frames                      : 0
        Tota tx Bytes                        : 0
        Discarded tx Frames                  : 0
        Discarded tx Bytes                   : 0
        Total Tx Frames with DE              : 0
        Total Tx Frames with FECN            : 0
        Tx Frames with FECN Tagged Locally   : 0
        Total Tx Frames with BECN            : 0
        Tx Frames with BECN Tagged Locally   : 0
Receive Direction :
        Rx Frames                            : 7071
```

```
        Rx Bytes                              : 2432424
        Rx Frames Discarded                   : 3
        Rx Bytes Discarded                    : 1032
        Total Rx Frames with DE               : 0
        Rx Frames with DE Tagged Locally      : 0
        Total Rx Frames with FECN             : 0
        Rx Frames with FECN Tagged Locally    : 0
        Total Rx Frames with BECN             : 0
        Rx Frames with BECN Tagged Locally    : 0
→ Rx connection-traffic-table-index: 102
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
→ Rx Frame Size : 64
→ Tx connection-traffic-table-index: 102
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
→ Tx Frame Size : 64

Switch#
```

The Rx Frame Size and Tx Frame Size fields display the new VC frame size configuration.

Step 6 Use the **show running-config** command to confirm GAT is configured on the interface VC.

```
Switch# show running-config interface serial 1/0/1:1
Building configuration...

Current configuration : 268 bytes
!
interface Serial1/0/1:1
 no ip address
 encapsulation frame-relay IETF
 no ip route-cache
 no ip mroute-cache
 no arp frame-relay
 frame-relay intf-type nni
 frame-relay soft-vc 128  dest-address 47.0091.8100.0000.0090.2156.d801.4000.0c80.1010.00
dlci 43 rx-cttr 102 tx-cttr 102 gat
end

Switch#
```

The keyword "gat" appears in the interface VC configuration confirming GAT is enabled.

Configuring LMI

Three industry-accepted standards are supported for addressing the Local Management Interface (LMI), including the Cisco specification. By default, the Cisco ILMI option is active on your Frame Relay interface.

Configuring the LMI Type

To manually set an LMI type on your Frame Relay port adapter, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay lmi-type** [**cisco** | **ansi** | **q933a**]	Selects Frame Relay LMI type.
Step 3	Switch(config-if)# **end** Switch#	Exits interface configuration mode.
Step 4	Switch# **copy system:running-config nvram:startup-config**	Writes the LMI type to NVRAM.

Example

The following example changes the LMI type to ansi on serial interface 1/1/0:1:

```
Switch(config)# interface serial 1/1/0:1
Switch(config-if)# frame-relay lmi-type ansi
Switch(config-if)# end
Switch# copy system:running-config nvram:startup-config
```

Displaying LMI Type

To display the LMI type configuration, perform the following task in user EXEC mode:

Command	Purpose
show frame-relay lmi interface serial *card***/***subcard***/***port***:***cgn*	Displays LMI type configuration.

Example

The following example displays the LMI type configuration of a Frame Relay port adapter:

```
Switch> show frame-relay lmi interface serial 1/1/0:1

LMI Statistics for interface Serial1/1/0:1 (Frame Relay NNI) LMI TYPE = ANSI
  Invalid Unnumbered info 0            Invalid Prot Disc 0
  Invalid dummy Call Ref 0             Invalid Msg Type 0
  Invalid Status Message 0             Invalid Lock Shift 0
  Invalid Information ID 0             Invalid Report IE Len 0
  Invalid Report Request 0             Invalid Keep IE Len 0
  Num Status Enq. Rcvd 5103            Num Status msgs Sent 5103
  Num Update Status Rcvd 0             Num St Enq. Timeouts 10
  Num Status Enq. Sent 5118            Num Status msgs Rcvd 5103
  Num Update Status Sent 0             Num Status Timeouts 14
```

Configuring the LMI Keepalive Interval

A keepalive interval must be set to configure the LMI. By default, this interval is 10 seconds and, per the LMI protocol, must be set as a positive integer that is less than the lmi-t392dce interval set on the interface of the neighboring switch.

To set the keepalive interval, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **keepalive** *number*	Selects the keepalive interval.

Example

The following example configures the LMI keepalive interval to 30 seconds:

```
Switch(config)# interface serial 1/1/0:1
Switch(config-if)# keepalive 30
```

Displaying LMI Keepalive Interval

To display the LMI keepalive interval, perform the following task in user EXEC mode:

Command	Purpose
show frame-relay lmi interface serial *card***/***subcard***/***port***:***cgn*	Displays LMI keepalive interval.

Example

The following example displays the LMI keepalive interval of a Frame Relay port adapter:

```
Switch> show interfaces serial 1/1/0:1
Serial1/1/0:1 is up, line protocol is up
  Hardware is FRPAM-SERIAL
  MTU 4096 bytes, BW 640 Kbit, DLY 0 usec, rely 255/255, load 1/255
➔ Encapsulation FRAME-RELAY IETF, loopback not set, keepalive set (30 sec)
  LMI enq sent  5163, LMI stat recvd 5144, LMI upd recvd 0, DTE LMI up
  LMI enq recvd 5154, LMI stat sent  5154, LMI upd sent  0, DCE LMI up
  LMI DLCI 1023  LMI type is CISCO  frame relay NNI
  Last input 00:00:04, output 00:00:20, output hang never

<Information Deleted>
```

Configuring the LMI Polling and Timer Intervals (Optional)

You can set various optional counters, intervals, and thresholds to fine-tune the operation of your LMI on your Frame Relay devices. Set these attributes by performing one or more of the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay lmi-n391dte** *keep-exchanges*	Configures an NNI full status polling interval.
Step 3	Switch(config-if)# **frame-relay lmi-n392dce** *threshold*	Configures the DCE and the NNI error threshold.
Step 4	Switch(config-if)# **frame-relay lmi-n392dte** *threshold*	Configures the NNI error threshold.
Step 5	Switch(config-if)# **frame-relay lmi-n393dce** *events*	Configures the DCE and NNI monitored events count.
Step 6	Switch(config-if)# **frame-relay lmi-n393dte** *events*	Configures the monitored event count on an NNI interface.
Step 7	Switch(config-if)# **frame-relay lmi-t392dce** *seconds*	Configures the polling verification timer on a DCE or NNI interface.

Example

The following example shows how to change the default polling verification timer on a Frame Relay interface to 20 seconds using the **frame-relay lmi-t392dce** command.

```
Switch(config)# interface serial 0/1/0:5
Switch(config-if)# frame-relay lmi-t392dce 20
```

Displaying Frame Relay Serial Interface

To display information about a serial interface, perform the following task in user EXEC mode:

Command	Purpose
show interfaces serial *card***/***subcard***/***port***:***cgn*	Displays Frame Relay serial interface configuration.

Example

The following example displays serial interface configuration information for an interface with Cisco LMI enabled:

```
Switch> show interfaces serial 0/1/0:5
Serial 0/1/0:5 is up, line protocol is up
    Hardware is FRPAM-SERIAL
    MTU 4096 bytes, BW 1536 Kbit, DLY 0 usec, rely 229/255, load 14/255
    Encapsulation FRAME-RELAY IETF, loopback not set, keepalive set (10 sec)
    LMI enq sent 0, LMI stat recvd 0, LMI upd recvd 0
➔   LMI DLCI 1023 LMI type is CISCO frame relay DCE
<information deleted>
```

Displaying LMI Statistics

To display statistics about the LMI, perform the following task in user EXEC mode:

Command	Purpose
show frame-relay lmi interface serial *card***/***subcard***/***port***:***cgn*	Displays LMI statistics.

Example

The following example displays the LMI statistics of a Frame Relay port adapter with an NNI interface:

```
Switch> show frame-relay lmi interface serial 0/1/0:5
LMI Statistics for interface serial 0/1/0:5 (Frame Relay NNI) LMI Type = Cisco
Invalid Unnumberred info 0Invalid Prot Disc 0
Invalid dummy Call Ref 0Invalid msg Type 0
Invalid Status Message 0Invalid Lock Shift 0
Invalid Information ID 0Invalid Report IE Len 0
Invalid Report Request 0Invalid Keep IE Len 0
Num Status Enq. Rcvd 11Num Status msgs Sent 11
Num Update Status Rcvd 0Num St Enq Timeouts 0
Num Status Enq. Sent 10Num Status msgs Rcvd 10
Num Update Status Sent 0Num Status Timeouts 0
```

Configuring Frame Relay to ATM Resource Management

This section describes the following resource management tasks specifically for your Frame Relay to ATM interworking network needs:

- Configuring Frame Relay to ATM Connection Traffic Table Rows, page 20-18
- Creating a Frame Relay to ATM CTT Row, page 20-21
- Configuring the Interface Resource Management Tasks, page 20-22

For information about how to configure your ATM Connection Traffic Table rows, see Chapter 9, "Configuring Resource Management."

Configuring Frame Relay to ATM Connection Traffic Table Rows

A row in the Frame Relay to ATM Connection Traffic Table (CTT) must be created for each unique combination of Frame Relay traffic parameters. All Frame Relay to ATM interworking virtual connections then provide traffic parameters for each row in the table per flow (receive and transmit). Multiple virtual connections can refer to the same traffic table row.

The Frame Relay traffic parameters (specified in the command used to create the row) are converted into equivalent ATM traffic parameters. Both parameters are stored internally and used for interworking virtual connections.

The formula used for Frame Relay to ATM traffic conversions are specified in the B-ICI specification, V2.0. Use a frame size (*n*) of 250 bytes and a header size of 2 bytes. See Table 20-1.

Table 20-1 Frame Relay to ATM Traffic Conversion

Peak Cell Rate (0+1) (Cells Per Second) =	Peak Information Rate[1] /8 * (6/260)
Sustainable Cell Rate (0) (Cells Per Second) =	Committed Information Rate[1] /8 * (6/250)
Maximum Burst Size (0) (Cells) =	(Committed Burst Size[2] /8 * (1/(1-Committed InformationRate/PeakInformationRate))+1)*(6/250)

1. In bits per second
2. In bits

You can also use the following generic formula to calculate Frame Relay to ATM traffic conversion:

- PCR = Peak Cell Rate (cells/sec)
- SCR = Sustained Cell Rate (cells/sec)
- MBS = Maximum Burst Size (cells)
- Bc = Committed Burst size (bits)
- Be = Excess Burst Size (bits)
- CIR = Committed Information Rate (bits/sec),
- PIR = Peak Information Rate (bits/sec),
- OHB(n)= Overhead Factor for frame-size(n)
- h1 = Frame Relay Header Size (octets), 2-octet
- h2 = AAL Type 5 PDU Trailer Size (8 octets)
- n = configured frame size
  - OHB(n) = [((n+h1+h2)/48) / n]
    where
    ((n+h1+h2)/48) value is to be rounded to the nearest integer
  - Peak Cell Rate (PCR) (0+1) (Cells Per Second)(0+1) (Cells Per Second) = PIR/8 [OHB (n)]
  - Sustainable Cell Rate (SCR) (0) (Cells Per Second) = CIR/8 [OHB (n)]
  - Maximum Burst Size (MBS)(0) (Cells) = [Bc/8 (1/(1 –(CIR/PIR))) + 1] [OHB (n)]

Example

Using the following values and example generic formula, MBS equals 47 cells:

- CIR=32000
- PIR=64000
- Bc=4000
- frame-size=64bytes

```
OHB(n) = [((n+h1+h2)/48) / n ] = [((64 + 2 + 8) / 48) / 64]
                               = (74/48) / 64
                               =  1.541 / 64
                             ROUNDING 1.541 TO 2
                       OHB(64) = 2/64

PCR = PIR/8 [OHB (n)]  = 64000/8 [2/64]
                       = 250
              Converting Cells/sec to Kbps
                       = 250 * 424 / 1000
                   PCR = 106 kbps

SCR = CIR/8 [OHB (n)]  = 32000/8 [2/64]
                       = 125
              Converting Cells/sec to Kbps
                       = 125 * 424 / 1000
                   SCR = 53 kbps
```

```
MBS = [Bc/8 ( 1/(1 -(CIR/PIR))) + 1 ] [OHB (n)]
    = [4000/8 (1/(1 -(32000/64000))+1] [2/64]
    = [500 ( 1 / 0.5 ) +1] [2/64]
    = [500 (2 +1)] [2/64]
    = [1500][2/64]
    = 46.875
Rounded of to next integer
MBS = 47
```

The Bc and Be values must be at least equal to the frame-size (calculated in bits). The Bc value indicates how long the VC can accommodate a burst above CIR. It depends entirely on the source of the traffic, how bursty it is, and how much the administrator will allow the VC to burst. There is no problem if the Bc, Be values are configured higher than the input burst coming from the VC.

Note If you configure a high value for Bc and if you have enabled Overflow-Queuing then switching to Overflow-Queuing will be delayed by the factor (Bc – Frame-size [of the incoming traffic]).

Roughly, the value is related to the number of frames the VC can accommodate with a continuous burst without tagging DE based on (CIR, Bc) [dropping based on ((PIR-CIR), Be)]. So, the Bc and Be values should always be more than the frame-size of the largest frame that is expected on the VC. If the interface bandwidth is high compared to the CIR then it is better have a larger Bc value. Similarly, Be (PIR-CIR) should be considered.

The following scenario describes when you might need to have higher Bc and Be values:

Usually the CIR is much less than the interface-rate. On a serial interface you get a complete frame at the interface-rate than at the configured CIR since you need to send a complete frame and start sending the next frame. In the event the other VCs have nothing to send, that bandwidth is used to send the traffic on the serial interface (provided the incoming traffic is not shaped). In that event, you should expect more frames to be dumped on to the Frame Relay ATM module and expect them to be shaped and sent. If the module is expected to accommodate more frames without dropping them due to UPC the best solution is to increase Bc and Be values.

PVC Connection Traffic Rows

Permanent virtual channel (PVC) connection traffic rows, or stable rows, are used to specify traffic parameters for PVCs.

Note PVC connection traffic rows cannot be deleted while in use by a connection.

SVC Connection Traffic Rows

SVC connection traffic rows, or transient rows, are used by the signalling software to obtain traffic parameters for soft SVCs.

Note SVC connection traffic rows cannot be deleted from the CLI or SNMP. They are automatically deleted when the connection is removed.

To make the CTT management software more efficient, the CTT row-index space is split into space allocated by the CLI/SNMP and signalling. See Table 20-2.

Table 20-2 CTT Row-Index Allocation

Allocated By	Row-Index Range
CLI/SNMP	1 through 1,073,741,823
Signalling	1,073,741,824 through 2,147,483,647

Predefined Rows

Table 20-3 describes the predefined row:

Table 20-3 Default Frame Relay to ATM Connection Traffic Table Row

CTT Row-Index	CIR (bits/s)	Bc (bits)	Be (bits)	PIR (bits/s)	Service Category	ATM Row-Index
100	64,000	32,768	32,768	64,000	VBR-NRT	100

Creating a Frame Relay to ATM CTT Row

To create a Frame Relay to ATM CTT row, perform the following task in global configuration mode:

Command	Purpose
frame-relay connection-traffic-table-row [**index** *row-index*] *cir-value bc-value pir-value be-value* {**abr** | **vbr-nrt** | **ubr**} [*atm-row-index*]	Configures a Frame Relay to ATM CTT row.

If you do not specify an index row number, the system software determines if one is free. The index row number is then displayed in the allocated index field if the command is successful.

If the ATM row index is not specified, system software tries to use the same row index used by Frame Relay. If not possible, a free ATM row index is used.

Example

The following example shows how to configure a Frame Relay to ATM CTT row with non-real-time variable bit rate (VBR-NRT) service category, committed information rate of 64000 bits per second, a peak information rate of 1536000 bits per second, and a committed burst size of 8192 bits per second:

```
Switch(config)# frame-relay connection-traffic-table-row 64000 8192 1536000 vbr-nrt
Allocated index = 64000
Switch(config)#
```

Displaying the Frame Relay to ATM Connection Traffic Table

To display the Frame Relay to ATM CTT configuration, use the following EXEC command:

Command	Purpose
show frame-relay connection-traffic-table-row [**from-row** *row* | **row** *row*]	Displays the Frame Relay to ATM CTT configuration.

Example

The following example shows how to display the Frame Relay to ATM CTT configuration table:

```
Switch# show frame-relay connection-traffic-table-row
Row      cir       bc        be        pir       FR-ATM    Service Category  ATM row
100      64000   32768     32768     64000                       vbr-nrt        100
```

Configuring the Interface Resource Management Tasks

The following resource management tasks configure queue thresholds, committed burst size, and service overflow on Frame Relay interfaces. To change any of these interface parameters, perform the following steps, in interface configuration mode:

	Command	Purpose
Step 1	Switch(config-if)# **frame-relay input-queue** {**abr** | **ubr** | **vbr-nrt**} {**discard-threshold** | **marking-threshold**} *threshold*	Configures discard and marking thresholds for the inbound direction.
Step 2	Switch(config-if)# **frame-relay output-queue** {**abr** | **ubr** | **vbr-nrt**} {**discard-threshold** | **marking-threshold**} *threshold*	Configures discard and marking thresholds for the outbound direction.
Step 3	Switch(config-if)# **frame-relay bc-default** *bc-value*	Configures the committed burst size (in bits) used for ABR/UBR soft VCs on the destination interface.
Step 4	Switch(config-if)# **frame-relay accept-overflow**	Configures existing connections to accept or discard overflow traffic (exceeding CIR) for VBR circuits. **Note** Unavailable on CDS3 Frame Relay interfaces.
Step 5	Switch(config-if)# **frame-relay overbooking** *percent*	Configures the percentage of CIR overbooking.

Note Step 4 affects existing and future connections on the Frame Relay interface, but Steps 1, 2, 3 and 5 affect only future connections.

Displaying Frame Relay Interface Resources

To display your Frame Relay interface resource configuration, use the following EXEC command:

Command	Purpose
show frame-relay interface resource serial *card/subcard/port***:***cgn*	Displays resource allocation on a Frame Relay interface.

Example

The resource information for Frame Relay serial interface 0/1/0:5 is displayed in the following example:

```
Switch# show frame-relay interface resource serial 0/1/0:5
Encapsulation: FRAME-RELAY
Input queues (PAM to switch fabric):
              Discard threshold: 87% vbr-nrt, 87% abr, 87% ubr
              Marking threshold: 75% vbr-nrt, 75% abr, 75% ubr
        Output queues (PAM to line):
              Discard threshold: 87% vbr-nrt, 87% abr, 87% ubr
              Marking threshold: 75% vbr-nrt, 75% abr, 75% ubr
            Overflow servicing for VBR: enabled
    Resource Management state:
          Available bit rates (in bps):
             320000 vbr-nrt RX, 320000 vbr-nrt TX
             320000 abr RX,     320000 abr TX
             320000 ubr RX,     320000 ubr TX
          Allocated bit rates (in bps):
             0 vbr-nrt RX, 0 vbr-nrt TX
             0 abr RX,     0 abr TX
             0 ubr RX,     0 ubr TX
```

Configuring Frame Relay to ATM Virtual Connections

This section describes how to configure virtual connections (VCs) for Frame Relay to ATM interworking and Frame Relay to Frame Relay switching.

The tasks to configure virtual connections are described in the following sections:

- Characteristics and Types of Virtual Connections, page 20-24
- Configuring Frame Relay PVC Connections, page 20-24
- Configuring Frame Relay Soft PVC Connections, page 20-32

Characteristics and Types of Virtual Connections

The characteristics of the Frame Relay to ATM interworking VC, established when the VC is created, include the following:

- Frame Relay to ATM interworking parameters
- Committed information rate (CIR), committed burst size (Bc), excess burst size (Be), peak information rate (PIR) (that is, access rate [AR]) for Frame Relay
- Peak and average transmission rates for ATM
- Service category
- Cell sequencing integrity
- ATM adaption Layer 5 (AAL5) for terminating interworking PVC

These switching features can be turned off with the interface configuration commands.

Note For information about ATM VCCs, see Chapter 7, "Configuring Virtual Connections."

Note You can configure a maximum of 2000 virtual connections on a CDS3 or CE1 Frame Relay port adapter.

Table 20-4 lists the types of supported virtual connections.

Table 20-4 Supported Frame Relay to ATM Virtual Connection Types

Connection	Point-to-Point	Point-to-Multipoint	Transit	Terminate
Permanent virtual channel	3	–	3	3
Soft permanent virtual channel	3	–	3	–

Configuring Frame Relay PVC Connections

This section describes configuring Frame Relay to ATM interworking permanent virtual channels (PVC) connections.

You can configure the following Frame Relay PVC connections:

- Configuration Guidelines
- Configuring Frame Relay to ATM Network Interworking PVCs
- Configuring Frame Relay to ATM Service Interworking PVCs
- Configuring Terminating Frame Relay to ATM Service Interworking PVCs
- Configuring Frame Relay Transit PVCs

Configuration Guidelines

Perform the following tasks in a prescribed order before configuring a Frame Relay to ATM interworking permanent virtual channel (PVC):

Step 1 Configure the controller on the Frame Relay port adapter.

Step 2 Configure the T1 channel or E1 interface and channel group on the Frame Relay port adapter.

Step 3 Configure Frame Relay encapsulation and Frame Relay LMI on the serial port corresponding to the channel group configured in Step 2.

Step 4 Configure Frame Relay resource management tasks including Frame Relay connection traffic table rows.

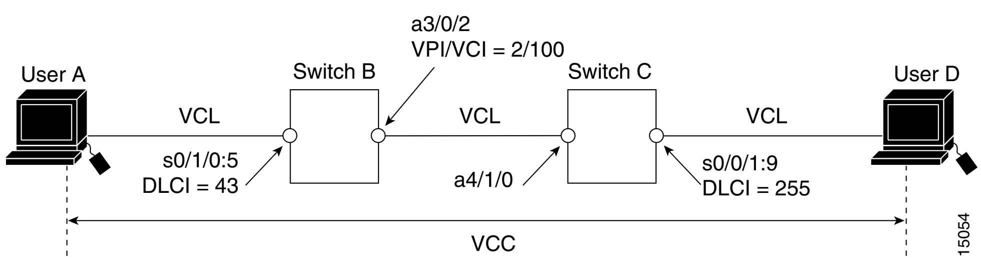
Step 5 Configure Frame Relay to ATM interworking VC tasks.

Configuring Frame Relay to ATM Network Interworking PVCs

This section describes configuring Frame Relay to ATM network interworking PVCs. This type of connection establishes a bidirectional facility that transfers Frame Relay traffic between two Frame Relay users through an ATM network.

Figure 20-3 shows an example of a Frame Relay to ATM network interworking PVC between Frame Relay User A and ATM User D through an ATM network.

Figure 20-3 Network Interworking PVC Example



To configure a Frame Relay to ATM network interworking PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn*[1] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci*[2] [**accept-overflow** {**enable** | **disable** | **inherit**}][3] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **network** [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**map-de** | **map-clp-or-de**}] [**interface atm** *card***/***subcard***/***port vpi vci* [**upc** *upc*] [**pd** {**off** | **on**}] [**rx-cttr** *index*] [**tx-cttr** *index*]]	Configures a Frame Relay to ATM network interworking PVC.

1. The serial interface is created with the **channel-group** command and configured using the **encapsulation frame-relay ietf** command. *cgn* is the channel group number of a channel group configured using the **channel-group** command.
2. The *dlci* value appears in the **Conn-Id** and **X-Conn-Id** columns of the **show vc** command.
3. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note When configuring PVC connections, configure the lowest virtual path identifier (VPI) and virtual channel identifier (VCI) numbers first.

Examples

The following example shows how to configure the internal cross-connect Frame Relay to ATM network interworking PVC on Switch B between serial interface 0/1/0:5, DLCI = 43 and ATM interface 3/0/2, VPI = 2, VCI = 100 (see Figure 20-3):

```
Switch-B(config)# interface serial 0/1/0:5
Switch-B(config-if)# frame-relay pvc 43 network interface atm 3/0/2 2 100
```

The following example shows how to configure the internal cross-connect PVC on Switch C between serial interface 0/0/1:9, DLCI = 255 and ATM interface 4/1/0, VPI = 2, VCI = 100:

```
Switch-C(config)# interface serial 0/0/1:9
Switch-C(config-if)# frame-relay pvc 255 network interface atm 4/1/0 2 100
```

Note The Frame Relay to ATM network interworking PVC must be configured from the serial interface and cross-connected to the ATM interface.

Displaying Frame Relay to ATM Network Interworking PVCs

To display the network interworking configuration, use the following EXEC command:

Command	Purpose
show vc [**interface** {**atm** *card*/*subcard*/*port* [*vpi vci*] | **serial** *card*/*subcard*/*port*:*cgn* [*dlci*]}]	Shows the PVC interface configuration.

Example

The following example displays the Switch B PVC configuration for serial interface 0/1/0:5:

```
Switch-B# show vc interface serial 0/1/0:5
Interface      Conn-Id    Type   X-Interface     X-Conn-Id   Encap  Status
Serial0/1/0:5    43       PVC     ATM3/0/2         2/100              UP
```

The following example displays the configuration of the Switch B PVC on serial interface 0/1/0:5, DLCI = 43:

```
Switch-B# show vc interface serial 0/1/0:5 43
Interface: Serial0/1/0:5, Type: FRPAM-SERIAL
DLCI = 43      Status : ACTIVE
```

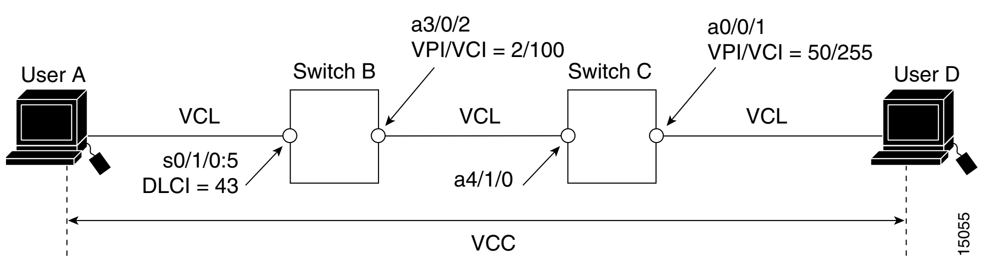
```
Connection-type: PVC
Cast-type: point-to-point
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 00:00:10      Time-since-last-status-change : 00:00:03
Interworking Function Type : network
de-bit Mapping : map-clp-or-de       clp-bit Mapping : map-de
ATM-P Interface: ATM-P0/1/0, Type: ATM-PSEUDO
ATM-P VPI = 82  ATM-P VCI = 11
ATM-P Connection Status: UP
Cross-connect-interface: ATM0/0/0, Type: oc3suni
Cross-connect-VPI = 2
Cross-connect-VCI = 100
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
tx Frames : 0   Rx Frames : 0
tx Bytes : 0    Rx Bytes : 0
tx Frames Discarded : 0         Rx Frames Discarded : 0
tx Bytes Discarded  : 0         Rx Bytes Discarded  : 0
Rx connection-traffic-table-index: 100
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
Tx connection-traffic-table-index: 100
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
```

Configuring Frame Relay to ATM Service Interworking PVCs

This section describes configuring Frame Relay to ATM service interworking permanent virtual channels (PVCs). A Frame Relay to ATM service interworking PVC is established as a bidirectional facility to transfer Frame Relay to ATM traffic between a Frame Relay user and an ATM user. The upper user protocol encapsulation (FRF.3, RFC 1483, RFC 1490, RFC 1577) mapping can be enabled with the translation option of the **frame-relay pvc** command.

Figure 20-4 shows an example of a Frame Relay to ATM service interworking PVC between Frame Relay User A and ATM User D through an ATM network.

Figure 20-4 Service Interworking PVC Example



Note VPI and VCI values can change when traffic is relayed through the ATM network.

To configure a Frame Relay to ATM service interworking PVC, perform the following steps beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card/subcard/port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}][1] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **service** {**transparent** | **translation**} [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**0** | **1** | **map-clp**}] [**efci-bit** {**0** | **map-fecn**}] [**interface atm** *card/subcard/port vpi* [*vci* | **any-vci**[2]] [**upc** {**pass** | **tag-drop**}] [**pd** {**off** | **on**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**encap** *aal-encap*] [**inarp** *minutes*]]	Configures a Frame Relay to ATM service interworking PVC.

1. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.
2. The **any-vci** option is only available on interface atm0. See note below.

Note Since release 12.0(1a)W5(5b) of the ATM switch software, addressing the interface on the route processor has changed. The ATM interface is now called atm0, and the Ethernet interface is now called ethernet0. Old formats (atm 2/0/0 and ethernet 2/0/0) are still supported.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Examples

The following example shows how to configure the internal cross-connect PVC on Switch B between serial interface 0/1/0:5, DLCI = 43, and ATM interface 3/0/2, VPI = 2, VCI = 100 (with the translation option):

```
Switch-B(config)# interface serial 0/1/0:5
Switch-B(config-if)# frame-relay pvc 43 service translation interface atm 3/0/2 2 100
```

The following example shows how to configure the internal cross-connect PVC on Switch C between ATM interface 4/1/0, VPI = 2, VCI = 100 and ATM interface 0/0/1, VPI 50, VCI = 255:

```
Switch-C(config)# interface atm 4/1/0
Switch-C(config-if)# atm pvc 2 100 interface atm 0/0/1 50 255
```

Each subsequent VC cross connection and link must be configured until the VC is terminated to create the entire PVC.

Note The Frame Relay to ATM service interworking PVC must be configured from the serial interface and then cross-connected to the ATM interface.

Displaying Frame Relay to ATM Service Interworking PVCs

To display the service interworking PVC configuration, use the following EXEC commands:

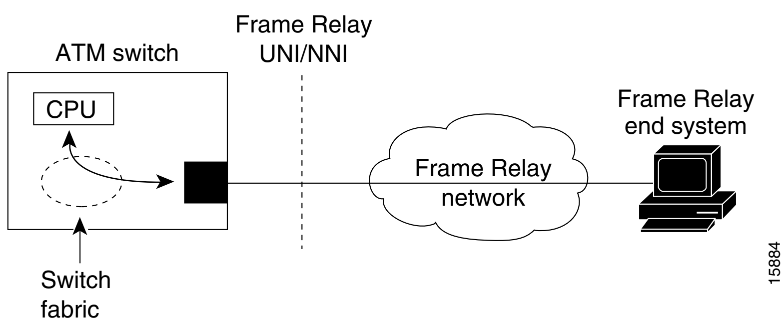
Command	Purpose
show interfaces [**serial** *card***/***subcard***/***port***:***cgn*]	Shows the serial interface configuration.
show vc [**interface** {**atm** *card***/***subcard***/***port* [*vpi vci*] | **serial** *card***/***subcard***/***port***:***cgn* [*dlci*]}]	Shows the PVC interface configuration.

Configuring Terminating Frame Relay to ATM Service Interworking PVCs

This section describes configuring terminating Frame Relay to ATM service interworking permanent virtual channels (PVCs). This type of terminating connection provides the connection from IP over Frame Relay to the ATM switch router used for IP over ATM and network management.

Figure 20-5 shows an example of transmit and terminating connections.

Figure 20-5 Frame Relay to ATM Transmit and Terminating Connections



Terminating connections are configured using the **frame-relay pvc** command; however, all switch terminating connections use atm0 to connect to the ATM switch route processor.

To configure terminating Frame Relay to ATM service interworking PVC connections, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card*/*subcard*/*port*:*cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **service** {**transparent** | **translation**} [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**0** | **1** | **map-clp**}] [**efci-bit** {**0** | **map-fecn**}] [**interface atm** *card*/*subcard*/*port vpi vci* | **any-vci**[1]] [**upc** {**pass** | **tag-drop**}] [**pd** {**off** | **on**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**encap** *aal-encap*] [**inarp** *minutes*]]	Configures a Frame Relay to ATM service interworking PVC.

1. The **any-vci** option is only available on interface atm0.

Example

The following example shows how to configure the internal cross-connect PVC on Switch B between serial interface 0/1/0:5, DLCI = 50, and the terminating connection on ATM interface 0, VPI = 0, and an unspecified VCI:

```
Switch-B(config)# interface serial 0/1/0:5
Switch-B(config-if)# frame-relay pvc 50 service translation interface atm 0 0 any-vci encap aal5snap
```

Note The Frame Relay to ATM service interworking PVC must be configured from the serial interface and then cross connected to the ATM interface.

Displaying Terminating Frame Relay to ATM Service Interworking PVCs

To display the service interworking PVC configuration, use the following EXEC commands:

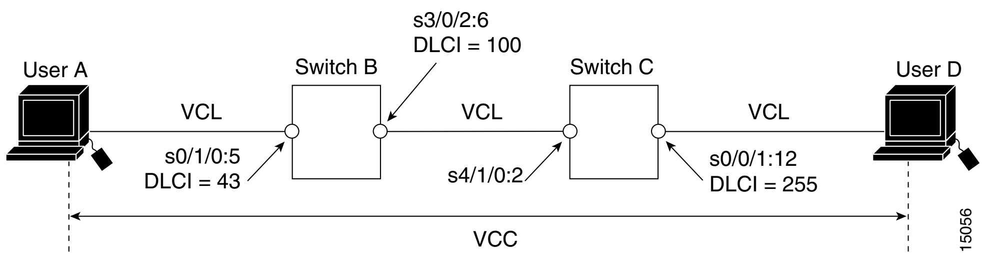
Command	Purpose
show interfaces [**serial** *card*/*subcard*/*port*:*cgn*]	Shows the serial interface configuration.
show vc [**interface** {**atm** *card*/*subcard*/*port* [*vpi vci*] | **serial** *card*/*subcard*/*port*:*cgn* [*dlci*]}]	Shows the PVC interface configuration.

Note See the Displaying Frame Relay to ATM Network Interworking PVCs, page 20-26 for examples of the **show vc** command.

Configuring Frame Relay Transit PVCs

This section describes configuring internal cross-connect Frame Relay to Frame Relay transit permanent virtual channels (PVCs). This type of PVC is used to establish a bidirectional facility to transfer Frame Relay traffic between two Frame Relay users. Figure 20-6 shows a Frame Relay transit PVC between Frame Relay users A and D.

Figure 20-6 Transit PVC Example



To configure a Frame Relay transit PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}][1] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **interface serial** *card***/***subcard***/***port***:***cgn* **dlci** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc {pass** | **tag-drop}**] [**rx-cttr** *index*] [**tx-cttr** *index*]	Configures a Frame Relay to Frame Relay transit PVC.

1. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.

Examples

The following example shows how to configure the internal cross-connect Frame Relay PVC on Switch B between serial interface 0/1/0:5, DLCI = 43, and serial interface 3/0/2:6, DLCI = 100:

```
Switch-B(config)# interface serial 0/1/0:5
Switch-B(config-if)# frame-relay pvc 43 interface serial 3/0/2:6 100
```

The following example shows how to configure the internal cross-connect Frame Relay on Switch C between serial interface 4/1/0:2, DLCI = 100,0 and serial interface 0/0/1:12, DLCI = 255:

```
Switch-C(config)# interface serial 4/1/0:2
Switch-C(config-if)# frame-relay pvc 100 interface serial 0/0/1:12 255
```

Each subsequent VC cross-connection and link must be configured until the VC is terminated to create the entire VCC.

To display Frame Relay transit PVCs, use the **show interfaces** and **show vc** commands.

Configuring Frame Relay Soft PVC Connections

This section describes configuring Frame Relay to ATM interworking soft permanent virtual channels (soft PVC) connections.

You can configure the following soft PVC connections:

- Frame Relay to Frame Relay soft PVC connection, configured as network interworking
- Frame Relay to ATM soft PVC connection, configured as network interworking
- Frame Relay to ATM soft PVC connection, configured as service interworking

Configuration Guidelines

These guidelines are appropriate for both network and service interworking soft PVC connections.

Note Frame Relay interworking soft PVCs can only be configured from a Frame Relay interface.

Perform the following steps, and see Figure 20-7:

Step 1 Determine which two switches you want to define as participants in the soft PVC.

Step 2 Determine the source (active) side of the soft PVC.

Step 3 Determine an available data-link connection identifier (DLCI) for value *dlci_a* on the source end of the soft PVC.

Step 4 Determine the destination (passive) side of the soft PVC.

Step 5 Determine the ATM address of the destination side of the soft PVC. Use the **show atm addresses** command on the destination switch.

Step 6 If the destination side of the soft PVC is a Frame Relay interface, choose an available DLCI value. Use the **show vc interface serial** command.

If the destination side of the soft PVC is an ATM interface, choose an available VPI/VCI value.

Step 7 Choose the interworking function type, and the relevant interworking parameters (for example, de-bit/clp-bit mapping options).

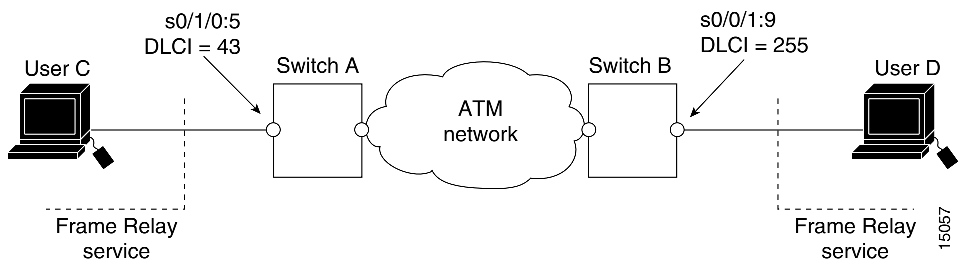
Note If the soft PVC terminates on a Frame Relay interface, the soft PVC can only be configured as a network interworking connection. If the soft PVC terminates on an ATM interface, the soft PVC can be configured either as a network interworking connection or a service interworking connection.

Step 8 Configure the Frame Relay interworking soft PVC on the source side. See the following sections for configuration steps and examples.

Configuring Frame Relay to Frame Relay Network Interworking Soft PVCs

This section describes how to configure a Frame Relay to Frame Relay network interworking soft PVC terminating on two Frame Relay interfaces. Figure 20-7 shows a Frame Relay to Frame Relay network interworking soft PVC between Switch A and Switch B.

Figure 20-7 Frame Relay to Frame Relay Network Interworking Soft PVC Example



To configure a Frame Relay to Frame Relay network interworking soft PVC, perform the following steps, beginning in EXEC mode:

	Command	Purpose
Step 1	Switch# **show interfaces**	Determines source and destination interfaces.
Step 2	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_a available for Step 7.
Step 3	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_b available for Step 7.
Step 4	Switch# **show atm addresses**	Determines soft PVC destination address.
Step 5	Switch# **configure terminal** Switch(config)#	From the source (active) side at the privileged EXEC prompt, enter configuration mode from the terminal.
Step 6	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the source Frame Relay port and channel group number.
Step 7	Switch(config-if)# **frame-relay soft-vc** [**accept-overflow** {**enable** | **disable** | **inherit**}][1] *dlci-a* **dest-address** *address* **dlci** *dlci_b* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc {pass** | **tag-drop}**] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *first-retry-interval*] [**maximum** *max-retry-interval*]] [**network [standard signal]** [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**map-de** | **map-clp-or-de**}]][**hold-priority** *priority*]	Configures a network interworking soft PVC terminating on a Frame Relay serial interface.

1. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.

The previous configuration steps are illustrated in the following section.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note To configure a soft PVC with priority, refer to "Configuring Soft PVCs and PVPs with Priority."

Frame Relay to Frame Relay Interworking Soft PVC Configuration Example

This section provides an example of a Frame Relay to Frame Relay network interworking soft PVC configured between Switch A and Switch B, as shown in Figure 20-7. The source (active) side is serial interface 0/1/0:5 on Switch A.

Step 1 Use the **show vc interface serial** command to determine that data-link connection identifier (DLCI) 43 is available on serial interface 0/1/0:5 on Switch A:

```
Switch-A# show vc interface serial 0/1/0:5
Interface      Conn-Id Type    X-Interface    X-Conn-Id  Encap  Status
Serial0/1/0:5     54  SoftVC   Serial3/0/0:3    54       SoftVC  UP
Serial0/1/0:5     55  SoftVC   Serial3/0/0:2    55       SoftVC  UP
Serial0/1/0:5     56  SoftVC   ATM0/1/3        0/45      SVC     UP
Serial0/1/0:5     66  SoftVC   ATM1/1/0        0/100     SoftVC  UP
```

Step 2 The destination (passive) side is a Frame Relay serial interface 0/0/1:9 on Switch B.

Step 3 The ATM address for the destination serial interface 0/0/1:9 on Switch B is 47.0091.8100.0000.00e0.1e79.8803.4000.0c81.8010.00.

```
Switch-B# show atm addresses
Switch Address(es):
47.00918100000000E01E798803.00E01E808601.00 active

Soft VC Address(es) :
47.0091.8100.0000.00e0.1e79.8803.4000.0c80.0000.00 ATM1/0/0
47.0091.8100.0000.00e0.1e79.8803.4000.0c80.0010.00 ATM1/0/1
47.0091.8100.0000.00e0.1e79.8803.4000.0c80.0020.00 ATM1/0/2
47.0091.8100.0000.00e0.1e79.8803.4000.0c80.0030.00 ATM1/0/3
<information deleted>

Soft VC Address(es) for Frame Relay Interfaces :
47.0091.8100.0000.00e0.1e79.8803.4000.0c81.8010.00 Serial0/0/1:9
47.0091.8100.0000.00e0.1e79.8803.4000.0c81.8020.00 Serial0/0/1:10

ILMI Switch Prefix(es):
47.0091.8100.0000.00e0.1e79.8803
<information deleted>
```

Step 4 DLCI 255 is available on serial interface 0/0/1:9 Switch B.

```
Switch-B# show vc interface serial 0/0/1:9
Interface Conn-Id Type X-Interface X-Conn-Id Encap Status
Serial0/0/1:9 44 SoftVC Serial3/0/0:3 54 SoftVC UP
Serial0/0/1:9 45 SoftVC Serial3/0/0:2 55 SoftVC UP
Serial0/0/1:9 76 SoftVC ATM0/1/3 0/45 SVC UP
Serial0/0/1:9 86 SoftVC ATM1/1/0 0/100 SoftVC UP
```

Step 5 Configure the network interworking soft PVC from Switch A beginning in global configuration mode.

```
Switch-A(config)# interface serial 0/1/0:5
Switch-A(config-if)# frame-relay soft-vc 43 dest-address
47.0091.8100.0000.00e0.1e79.8803.4000.0c81.8010.00 dlci 255
```

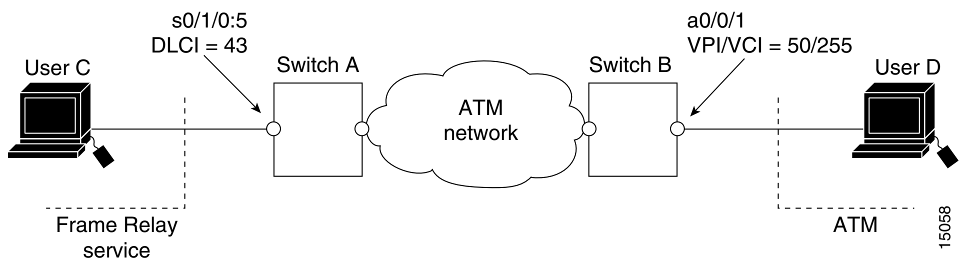
Note If the soft PVC originates and terminates on a Frame Relay interface, the default interworking type is network interworking. You do not need to specify the interworking type explicitly.

After you complete the soft VC configuration, proceed to Display Frame Relay Interworking Soft PVCs, page 20-39 and verify the connection.

Configuring Frame Relay to ATM Network Interworking Soft PVCs

This section describes how to configure a Frame Relay to ATM network interworking soft permanent virtual channel (soft PVC). Figure 20-8 shows a Frame Relay to ATM network interworking soft PVC between Switch A and Switch B.

Figure 20-8 Frame Relay to ATM Network Interworking Soft PVC Example



To configure a Frame Relay to ATM network interworking soft PVC, perform the following steps, beginning in EXEC mode:

	Command	Purpose
Step 1	Switch# **show interfaces**	Determines source and destination interfaces.
Step 2	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI available for Step 7.
Step 3	Switch# **show atm addresses**	Determines soft PVC destination address.
Step 4	Switch# **configure terminal** Switch(config)#	From the source (active) side, at the privileged EXEC prompt, enter configuration mode from the terminal.
Step 5	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the source Frame Relay port and channel group number.
Step 6	Switch(config-if)# **frame-relay soft-vc** [**accept-overflow** {**enable** | **disable** | **inherit**}][1] *dlci_a* **dest-address** *address* **dlci vc** *vpi vci* [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *first-retry-interval*] [**maximum** *max-retry-interval*]] [**network** [**clp-bit** {**0** | **1** | **map-de**}] **de-bit** {**map-de** | **map-clp-or-de**}]] [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**] [**hold-priority** *priority*]	Configures a network interworking soft PVC terminating on an ATM interface.

1. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.

The previous configuration steps are illustrated in the following section.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note To configure a soft PVC with priority, refer to "Configuring Soft PVCs and PVPs with Priority."

Frame Relay to ATM Network Interworking Soft PVC Configuration Example

This section provides an example of a network interworking soft PVC configured between switch A and Switch B and shown in Figure 20-9. The source (active) side is serial interface 0/1/0:5 on Switch A.

Step 1 Use the **show vc interface serial** command to determine that DLCI 43 is available on serial interface 0/1/0:5 Switch A.

```
Switch-A# show vc interface serial 0/1/0:5
Interface      Conn-Id Type     X-Interface    X-Conn-Id  Encap  Status
Serial0/1/0:5     54  SoftVC   Serial3/0/0:3    54        SoftVC  UP
Serial0/1/0:5     55  SoftVC   Serial3/0/0:2    55        SoftVC  UP
Serial0/1/0:5     56  SoftVC   ATM0/1/3         0/45      SVC     UP
Serial0/1/0:5     66  SoftVC   ATM1/1/0         0/100     SoftVC  UP
```

Step 2 On Switch B, use the **show atm addresses** command to determine the destination ATM address for ATM interface 0/0/1, which is 47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0010.00.

```
Switch-B# show atm addresses
Switch Address(es):
47.00918100000000E01E199904.00E01E808601.00 active
Soft VC Address(es) :
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0000.00 ATM0/0/0
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0010.00 ATM0/0/1
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0020.00 ATM0/0/2
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0030.00 ATM0/0/3
<information deleted>
```

Step 3 On Switch B, use the **show vc interface atm** command to determine that VPI/VCI 50/255 is available for use on ATM interface 0/0/1.

```
Switch-B# show vc interface atm 0/0/1
Interface     Conn-Id     Type    X-Interface      X-Conn-Id   Encap  Status
ATM0/0/1       0/5        PVC      ATM2/0/0          0/58      QSAAL    UP
ATM0/0/1       0/16       PVC      ATM2/0/0          0/44      ILMI     UP
ATM0/0/1       0/18       PVC      ATM2/0/0          0/71      PNNI     UP
```

Step 4 Configure the network interworking soft PVC from Switch A beginning in global configuration mode.

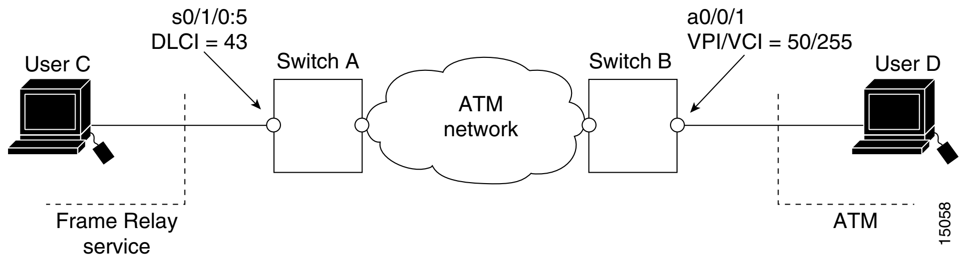
```
Switch-A(config)# interface serial0/1/0:5
Switch-A(config-if)# frame-relay soft-vc 43 dest-address
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0010.00 vc 50 255 network
```

After you complete the soft VC configuration, go to Display Frame Relay Interworking Soft PVCs, page 20-39 and verify the connection.

Configuring Frame Relay to ATM Service Interworking Soft PVCs

This section describes configuring a Frame Relay to ATM service interworking soft PVC terminating on an ATM interface. Figure 20-9 shows a Frame Relay to ATM service interworking soft PVC between Switch A and Switch B.

Figure 20-9 Frame Relay to ATM Service Interworking Soft PVC Example



To configure a Frame Relay to ATM service interworking soft PVC, perform the following steps, beginning in EXEC mode:

	Command	Purpose
Step 1	Switch# **show interfaces**	Determines source and destination interfaces.
Step 2	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI available for Step 7.
Step 3	Switch# **show atm addresses**	Determines the soft PVC destination address.
Step 4	Switch# **configure terminal** Switch(config)#	From the source (active) side, at the privileged EXEC prompt, enter configuration mode from the terminal.
Step 5	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the Frame Relay serial port and channel group number.
Step 6	Switch(config-if)# **frame-relay soft-vc** *dlci_a* **dest-address** *address* **vc** *vpi vci* [**accept-overflow** {**enable** | **disable** | **inherit**}][1][**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *first-retry-interval*] [**maximum** *max-retry-interval*]] [**service** [**translation** | **transparent**]] [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**0** | **1** | **map-clp**}] [**efci-bit** {**0** | **map-fecn**}] [**explicit-path precedence** {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**]	Configures a service interworking soft PVC.

1. The overflow queuing option is described in the section, Configuring Overflow Queuing, page 20-43.

Note The row index for **rx-cttr** and **tx-cttr** must be configured before using this optional parameter. See Chapter 9, "Configuring Resource Management."

Note If the interworking soft PVC terminates on an ATM interface, the default interworking type is service interworking in translation mode.

Frame Relay to ATM Service Interworking Soft PVC Configuration Example

Use the following steps to configure the service interworking soft PVC between Switch A and switch B as shown in Figure 20-9.

Note In the following process the source (active) side is serial interface 0/1/0:5 on Switch A and the destination (passive) side is ATM interface 0/0/1 on Switch B.

Step 1 On Switch A, use the **show vc interface serial** command to determine that DLCI 43 is available for use on serial interface 0/1/0:5 Switch A:

```
Switch-A# show vc interface serial 0/1/0:5
Interface      Conn-Id Type     X-Interface     X-Conn-Id  Encap  Status
Serial0/1/0:5      54  SoftVC   Serial3/0/0:3     54       SoftVC  UP
Serial0/1/0:5      55  SoftVC   Serial3/0/0:2     55       SoftVC  UP
Serial0/1/0:5      56  SoftVC   ATM0/1/3          0/45     SVC     UP
Serial0/1/0:5      66  SoftVC   ATM1/1/0          0/100    SoftVC  UP
```

Step 2 On Switch B, use the **show atm addresses** command to determine the destination ATM address for ATM interface 0/0/1, which is 47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0010.00.

```
Switch-B# show atm addresses
Switch Address(es):
47.00918100000000E01E199904.00E01E808601.00 active
Soft VC Address(es) :
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0000.00 ATM0/0/0
47.0→1.8100.0000.00e0.1e19.9904.4000.0c80.0010.00 ATM0/0/1
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0020.00 ATM0/0/2
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0030.00 ATM0/0/3
<information deleted>
```

Step 3 On Switch B, use the **show vc interface atm** command to determine that VPI/VCI 50/255 is available for use on ATM interface 0/0/1:

```
Switch-B# show vc interface atm 0/0/1
Interface     Conn-Id     Type   X-Interface      X-Conn-Id   Encap  Status
ATM0/0/1       0/5        PVC     ATM2/0/0           0/58     QSAAL    UP
ATM0/0/1       0/16       PVC     ATM2/0/0           0/44     ILMI     UP
ATM0/0/1       0/18       PVC     ATM2/0/0           0/71     PNNI     UP
```

Step 4 The following example configures a service interworking soft PVC in transparent mode on Switch A using the information obtained in the previous steps:

```
Switch-A(config)# interface serial 0/1/0:5
Switch-A(config-if)# frame-relay soft-vc 43 dest-address
47.0091.8100.0000.00e0.1e19.9904.4000.0c80.0010.00 vc 50 255 service transparent
```

After you complete the soft VC configuration, go to Display Frame Relay Interworking Soft PVCs, page 20-39 and verify the connection.

Display Frame Relay Interworking Soft PVCs

To display your Frame Relay interworking soft PVCs configuration, use the following EXEC command:

Command	Purpose
show vc [**interface** {**atm** *card***/***subcard***/***port* [*vpi vci*] | **serial** *card***/***subcard***/***port***:***cgn* [*dlci*]}]	Shows the PVC interface configuration.

Examples

The following example displays serial interface 1/1/0:2 soft PVC status:

```
Switch# show vc interface serial 1/1/0:2
Interface      Conn-Id    Type   X-Interface     X-Conn-Id   Encap  Status
Serial1/1/0:2     34      SoftVC  ATM0/0/0        100/255             UP
```

The following example displays ATM interface 0/0/0 soft PVC status:

```
Switch# show vc interface atm 0/0/0
Interface      Conn-Id    Type   X-Interface     X-Conn-Id   Encap  Status
ATM0/0/0          0/5       PVC    ATM2/0/0           0/43     QSAAL    UP
ATM0/0/0          0/16      PVC    ATM2/0/0           0/35     ILMI     UP
ATM0/0/0          0/200     PVC    ATM0/0/1           0/200             DOWN
ATM0/0/0        100/255     SoftVC  Serial1/1/0:2       34                UP
```

Modifying CTTR Indexes on an Existing Frame Relay Soft PVC

To change the CTTR indexes on an existing Frame Relay Soft PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the Frame Relay serial port and channel group number.
Step 2	Switch(config-if)# **frame-relay soft-vc** *dlci-source source-vci* [**rx-cttr** *index*] [**tx-cttr** *index*]	Specifies the new **rx-cttr** and **tx-cttr** indexes for the existing Soft PVC.
Step 3	Switch(config-if)# **end** Switch#	Switches to EXEC command mode.

Example

The following example modifies the CTTR indexes for an existing Frame Relay Soft PVC.

```
Switch(config)# interface atm 1/1/1
Switch(config-if)# frame-relay soft-vc 48 rx-cttr 102 tx-cttr 102
Switch(config-if)# end
Switch#
```

Standard Signalling for Frame Relay Soft PVCs

Standards-based signalling for Frame-Relay Soft PVCs requires using new fields in the calling and called Soft PVC Information Elements (IEs) to convey the local and remote Data Link Control Identifiers (DLCI). The default proprietary signalling also transmits the intended Discard Eligibility (DE) and Cell Loss Priority (CLP) -bit handling for the connection. This cannot be signalled if standard signalling is configured. To use standard signalling for soft PVCs, you can configure the Frame Relay interface to specify the default CLP or DE mapping for received soft PVC connections.

To set the default mode for received soft PVC connections in the Frame Relay to ATM direction, use the following interface command:

Command	Purpose
Switch(config-if)#**frame-relay called-soft-vc default clp-bit** [**0** | **1** | **map-de**]	Sets the default mode for received soft PVC connections in the Frame Relay to ATM direction, including the mode of DE/CLP mapping.

Note Values 0, 1, or **map-de** are allowed for both network interworking and service interworking. The default is **map-de**.

To set the default mode for received soft PVC connections in the ATM to Frame Relay direction, use the following interface command:

Command	Purpose
Switch(config-if)#**frame-relay called-soft-vc default de-bit** [**map-clp-or-de** | **map-de**]]	Sets the default mode for received soft PVC connections in the ATM to Frame Relay direction, including the mode of DE/CLP mapping.

Note For network interworking, values **map-de** or **map-clp-or-de** are allowed. The default value is **map-clp-or-de**. For service interworking, values 0, 1, or **map-clp** are allowed. The default is **map-clp**.

Configuring the Soft PVC Route Optimization Feature

This section describes the soft permanent virtual channel (soft PVC) route optimization feature for Frame Relay interfaces. Most soft PVCs have a much longer lifetime than switched virtual channels (SVCs). The route chosen during the soft connection setup remains the same even though the network topology might change.

Soft connections, with the route optimization percentage threshold set, provide the following features:

- When a better route is available, soft permanent virtual paths (soft PVPs) or soft PVCs are dynamically rerouted.
- Route optimization can be triggered manually.

Note Soft PVC route optimization should not be configured with constant bit rate (CBR) connections.

Configuring a Frame Relay Interface with Route Optimization

Soft PVC route optimization must be enabled and configured to determine the point at which a better route is found and the old route is reconfigured.

To enable and configure a Frame Relay interface with route optimization, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm route-optimization percentage-threshold** *value*	Configures the ATM route optimization threshold.
Step 2	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to configure. Enter the interface number of the source end of the soft PVC. Route optimization works for the source end of a soft PVC only and is ignored if configured on the destination interface.
Step 3	Switch(config-if)# **atm route-optimization soft-connection** [**interval** *minutes*] [**time-of-day** {**anytime** | *start-time end-time*}]	Configures the interface for route optimization.

Example

The following example shows how to configure an interface with a route optimization interval configured as every 30 minutes between the hours of 6:00 P.M. and 5:00 A.M.:

```
Switch(config)# atm route-optimization percentage-threshold 45
Switch(config)# interface serial 1/0/0:1
Switch(config-if)# atm route-optimization soft-connection interval 30 time-of-day 18:00 5:00
```

Displaying a Frame Relay Interface Route Optimization Configuration

To display the Frame Relay interface route optimization configuration, use the following privileged EXEC commands:

Command	Purpose
show running-config	Shows the serial interface configuration route optimization configuration.
show interfaces [**serial** *card***/***subcard***/***port***:***cgn*]	Shows the serial interface configuration.

Example

The following example shows the route optimization configuration of serial interface 1/0/0:1:

```
Switch# show running-config
Building configuration...

<information deleted>
```

```
!
interface Serial1/0/0:1
 description Engineering connections
 no ip address
 no ip directed-broadcast
 encapsulation frame-relay IETF
 no arp frame-relay
 no snmp trap link-status
 frame-relay intf-type nni

atm route-optimization soft-connection interval 30 time-of-day 18:0 5:0
!

Switch# show interfaces serial 3/0/0:1
Serial3/0/0:1 is up, line protocol is up
  Hardware is FRPAM-SERIAL
  MTU 4096 bytes, BW 1536 Kbit, DLY 0 usec, rely 128/255, load 1/255
  Encapsulation FRAME-RELAY IETF, loopback not set, keepalive not set
  Last input 00:00:08, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/0/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     12963 packets input, 12963 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     12963 input errors, 7638 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions
  Timeslots(s) Used: 1-24 on T1 1
  Frames Received with:
   DE set: 0, FECN set :0, BECN set: 0
  Frames Tagged :
   DE: 0, FECN: 0 BECN: 0
  Frames Discarded Due to Alignment Error: 0
  Frames Discarded Due to Illegal Length: 0
  Frames Received with unknown DLCI: 0
  Frames with illegal Header : 0
  Transmit Frames with FECN set :0,  BECN Set :0
  Transmit Frames Tagged FECN : 0 BECN : 0
  Transmit Frames Discarded due to No buffers : 0
  Default Upc Action : tag-drop
  Default Bc (in Bits) : 32768
➔ Soft vc route optimization is enabled
    Soft vc route optimization interval = 50 minutes
    Soft vc route optimization time-of-day range = (20:10 - 23:40)
```

Respecifying Existing Frame Relay to ATM Interworking Soft PVCs

For existing Frame Relay to ATM interworking soft permanent virtual channels (soft PVCs), a connection is disabled to prevent an explicit path from being used for routing while it is reconfigured. The **redo_explicit** keyword is used to allow respecifying of the explicit path configuration without bringing down connections. Existing connections remain unaffected unless a reroute takes place. If rerouting occurs, the new explicit path configuration takes effect.

To enable or disable soft PVC and respecify explicit-path configuration, use the following interface command:

Command	Purpose
frame-relay soft-vc *dlci_a* [**enable** | **disable**] [**redo-explicit** [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**]]	Respecifies the explicit path on a Frame Relay to ATM interworking soft PVC.

Configuring Overflow Queuing

Traffic shaping in the ingress direction (Frame Relay to ATM) is enabled by default for all VBR-nrt VCs on the Frame Relay ATM interface module. If you want to configure an individual VC to make use of the bandwidth available when the other VCs configured on the same interface are not using all the allocated bandwidth, you should configure overflow queuing on that VC.

For example, the policing functionality accepts frames until the PIR rate is reached, while the allowable burst and shaping functionality tries to send the cells to the switch fabric at SCR (CIR equivalent on the ATM side). If the CIR is very low compared to the PIR it could cause buffers to be held for a long time, allowing frame discards on that particular VC and other VCs on the same interface.

Enabling overflow queuing allows you to schedule the frames at a rate above SCR. This means when the bandwidth is available and when overflow queuing is enabled, the frames are sent at a higher rate.

Overflow queuing is optional and can be configured at the VC level or the interface level using the **enable**, **disable**, or **inherit** keywords.

Note Overflow queuing configured at VC level overrides the option configured at the interface level. But, only when the traffic exceeds the (CIR, Bc) bucket and Overflow-Queuing is configured for that VC will the Overflow-Queuing feature start.

If overflow queuing is not configured at the VC level, then it inherits the configuration parameters of the interface, which is “disabled” by default.

Also, VC level overflow queuing changes in synchronization with interface level overflow queuing. For example, if you enable or disable overflow queuing at the interface level, overflow queuing is enabled or disabled on those VBR-nrt VCs of that interface (if VC level overflow queuing is not already configured).

This section includes the following:

Overflow Queuing Functional Image Requirements

You must have functional image version 4.3 (fi-c8510-4e1fr.A.4.3), or later, installed on the Frame Relay interface module to use the overflow queuing feature. If your interface module has a functional image version earlier than 2.4 installed, you must first install intermediate functional image version 2.4 prior to upgrading to functional image version 4.3.

Note Overflow Queuing is not supported on the CDS3 interface module.

To load and upgrade functional images, see the "Maintaining Functional Images (Catalyst 8540 MSR)" section on page 26-5 and the "Maintaining Functional Images (Catalyst 8510 MSR and LightStream 1010)" section on page 26-7.

Configuring Overflow Queuing on Frame Relay to ATM PVCs

This section describes configuring overflow queuing for Frame Relay to ATM PVCs for both network internetworking and service internetworking connections.

Network Internetworking PVCs

To configure overflow queuing for Frame Relay to ATM PVCs for network internetworking connections, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card/subcard/port***:***cgn*[1] Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci*[2] [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **network** [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**map-de** | **map-clp-or-de**}] [**interface atm** *card/subcard/port vpi vci* [**upc** *upc*] [**pd** {**off** | **on**}] [**rx-cttr** *index*] [**tx-cttr** *index*]]	Configures a Frame Relay to ATM network interworking PVC.

1. The serial interface is created with the **channel-group** command and configured using the **encapsulation frame-relay ietf** command. *cgn* is the channel group number of a channel group configured using the **channel-group** command.
2. The *dlci* value appears in the **Conn-Id** and **X-Conn-Id** columns of the **show vc** command.

Example

The following example shows how to enable overflow queuing on a network internetworking PVC cross connected between serial interface 11/1/0:9, DLCI = 100 and ATM interface 0/0/0, VPI = 1, VCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 100 accept-overflow enable rx-cttr 100 tx-cttr 100
network interface atm 0/0/0 1 100
```

The following example shows how to enable overflow queuing on an existing network internetworking PVC at serial interface 11/1/0:9, DLCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 100 accept-overflow enable
```

Service Internetworking PVC Connections

To configure overflow queuing for Frame Relay to ATM PVCs for service internetworking connections, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc {pass** | **tag-drop}**] [**rx-cttr** *index*] [**tx-cttr** *index*] **service** {**transparent** | **translation**} [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**0** | **1** | **map-clp**}] [**efci-bit** {**0** | **map-fecn**}] [**interface atm** *card***/***subcard***/***port vpi vci* | **any-vci**[1]] [**upc {pass** | **tag-drop}**] [**pd** {**off** | **on**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**encap** *aal-encap*] [**inarp** *minutes*]]	Configures a Frame Relay to ATM service interworking PVC.

1. The **any-vci** option is only available on interface atm0.

Examples

The following example shows how to enable overflow queuing on a service *translation* internetworking PVC cross connected between serial interface 11/1/0:9, DLCI = 100 and ATM interface 0/0/0, VPI = 1, VCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 100 accept-overflow enable rx-cttr 100 tx-cttr 100
service translation interface atm 0/0/0 1 100
```

The following example shows how to enable overflow queuing on a service *transparent* internetworking PVC cross connected between serial interface 11/1/0:9, DLCI = 100 and ATM interface 0/0/0, VPI = 1, VCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 100 accept-overflow enable rx-cttr 100 tx-cttr 100
service transparent interface atm 0/0/0 1 100
```

Configuring Overflow Queuing on Frame Relay to Frame Relay PVCs

To configure overflow queuing on a Frame Relay transit PVC, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the interface to be configured.
Step 2	Switch(config-if)# **frame-relay pvc** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] **interface serial** *card***/***subcard***/***port***:***cgn* **dlci** *dlci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*]	Configures a Frame Relay to Frame Relay transit PVC.

Examples

The following example shows how to enable overflow queuing on a Frame Relay PVC cross connected between serial interface 11/1/0:9, DLCI = 200 and serial interface 3/0/0:1, DLCI = 200:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 200 accept-overflow enable interface serial 3/0/0:1 200
```

Note Default overflow queuing configuration (for example, inherit from interface) is applied at the destination end.

The following example shows how to enable overflow queuing on the source Frame Relay PVC cross connected between serial interface 11/1/0:9, DLCI = 201 and serial interface 3/0/0:1, DLCI = 201, where the destination end has overflow queuing disabled:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 201 accept-overflow enable interface serial 3/0/0:1 201
accept-overflow disable
```

The following example shows how to enable overflow queuing on an existing PVC connection at serial interface 11/1/0:9, DLCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay pvc 100 accept-overflow enable
```

Note The destination end has overflow queuing disabled.

Following are the possible Frame Relay to Frame Relay connections overflow queuing combinations:

- Enabled—Enabled
- Enabled—Disabled
- Enabled—Inherited
- Enabled—Not mentioned

- Disabled—Enabled
- Disabled—Disabled
- Disabled—Inherited
- Disabled—Not mentioned
- Inherited—Enabled
- Inherited—Disabled
- Inherited—Inherited
- Inherited—Not mentioned
- Not mentioned—Enabled
- Not mentioned—Disabled
- Not mentioned—Inherited
- Not mentioned—Not mentioned

Note In the previous list, "Not mentioned" equals the default.

Configuring Overflow Queuing on Frame Relay to ATM Soft PVCs

To configure overflow queuing for Frame Relay to ATM network interworking Soft PVC, perform the following steps, beginning in EXEC mode:

	Command	Purpose
Step 1	Switch# **show interfaces**	Determines source and destination interfaces.
Step 2	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_a switch available for Step 7.
Step 3	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_b switch available for Step 7.
Step 4	Switch# **show atm addresses**	Determines soft PVC destination address.
Step 5	Switch# **configure terminal** Switch(config)#	From the source (active) side, at the privileged EXEC prompt, enter configuration mode from the terminal.

	Command	Purpose
Step 6	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the source Frame Relay port and channel group number.
Step 7	Switch(config-if)# **frame-relay soft-vc** *dlci-a* [**accept-overflow** {**enable** | **disable** | **inherit**}] **dest-address** *address* **vc** *vpi vci* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**retry-interval** [**first** *first-retry-interval*] [**maximum** *max-retry-interval*]] [**network** [**clp-bit** {**0** | **1** | **map-de**}] **de-bit** {**map-de** | **map-clp-or-de**}]] [**explicit-path** *precedence* {**name** *path-name* | **identifier** *path-id*} [**upto** *partial-entry-index*]] [**only-explicit**] [**hold-priority** *priority*]	Configures a network interworking soft PVC terminating on an ATM interface.

Examples

The following example shows how to create a Soft-PVC between serial interface 11/1/0:10, DLCI = 500 with overflow queuing enabled and ATM destination VC, VPI = 5, VCI = 500:

```
Switch(config-if)# frame-relay soft-vc 500 accept-overflow enable
 dest-address 47.0091.8100.0000.0004.ddec.d401.4000.0c91.8010.00 vc 5 500
```

The following example shows how to enable overflow queuing on an existing Soft PVC connection at serial interface 11/1/0:9, DLCI = 100:

```
Switch(config)# interface serial11/1/0:9
Switch(config-if)# frame-relay soft-vc 100 accept-overflow enable
```

Configuring Overflow Queuing on Frame Relay to Frame Relay Soft PVCs

To configure overflow queuing for Frame Relay to Frame Relay Soft PVC, perform the following steps, beginning in EXEC mode:

	Command	Purpose
Step 1	Switch# **show interfaces**	Determines source and destination interfaces.
Step 2	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_a switch available for Step 7.
Step 3	Switch# **show vc interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]	Determines the DLCI_b switch available for Step 7.
Step 4	Switch# **show atm addresses**	Determines the soft PVC destination address.
Step 5	Switch# **configure terminal** Switch(config)#	From the source (active) side at the privileged EXEC prompt, enter configuration mode from the terminal.

	Command	Purpose
Step 6	Switch(config)# **interface serial** *card***/***subcard***/***port***:***cgn* Switch(config-if)#	Selects the source Frame Relay port and channel group number.
Step 7	Switch(config-if)# **frame-relay soft-vc** [**accept-overflow** {**enable** | **disable** | **inherit**}] *dlci-a* **dest-address** *address* **dlci** *dlci_b* [**accept-overflow** {**enable** | **disable** | **inherit**}] [**upc** {**pass** | **tag-drop**}] [**rx-cttr** *index*] [**tx-cttr** *index*] [**gat**] [**retry-interval** [**first** *first-retry-interval*] [**maximum** *max-retry-interval*]] [**network [standard signal]** [**clp-bit** {**0** | **1** | **map-de**}] [**de-bit** {**map-de** | **map-clp-or-de**}]][**hold-priority** *priority*]	Configures a network interworking soft PVC terminating on a Frame Relay serial interface.

Examples

The following example shows how to create a Soft PVC between serial interface 11/1/0:11, DLCI = 501 with overflow queuing enabled and destination DLCI = 501 that also has overflow queuing and GAT enabled:

```
Switch(config)# interface serial11/1/0:11
Switch(config-if)# frame-relay soft-vc 501 accept-overflow enable dest-address
47.0091.8100.0000.0004.ddec.d401.4000.0c81.8010.00 dlci 501 accept-overflow enable gat
```

Note When configuring overflow queuing on Frame Relay to Frame Relay Soft PVCs, GAT must be enabled or the **accept-overflow** configuration is not signalled to the destination side.

Displaying Overflow Queuing Configuration at the VC Level

To display overflow queuing at the VC level, use the following EXEC command:

Command	Purpose
show vc [**interface serial** *card***/***subcard***/***port***:***cgn* [*dlci*]]	Shows the PVC interface configuration.
show running-config [**interface serial** *card***/***subcard***/***port***:***cgn*]	Shows the interface configuration.

Examples

The following example displays the overflow queuing configuration of VC serial interface 1/0/0:1 DLCI 100:

```
Switch# show vc interface serial 1/0/0:1 100
Interface: Serial1/0/0:1, Type: FRPAM-SERIAL
DLCI = 100      Status : ACTIVE   Peer Status : INACTIVE
Connection-type: PVC
Cast-type: point-to-point
➔ Per VC Overflow Status: Disabled
➔ User Configured Option is: Disable
```

```
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 16:26:00      Time-since-last-status-change : 16:25:54
Interworking Function Type : network
de-bit Mapping : map-clp-or-de       clp-bit Mapping : map-de
ATM-P Interface: ATM-P1/0/0, Type: ATM-PSEUDO
ATM-P VPI = 1  ATM-P VCI = 132
ATM-P Connection Status: UP
Cross-connect-interface: ATM0/0/0, Type: oc3suni
Cross-connect-VPI = 1
Cross-connect-VCI = 100
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Cross-connect-UPC: pass
Transmit Direction :
        Total tx Frames                      : 0
        Tota tx Bytes                        : 0
        Discarded tx Frames                  : 0
        Discarded tx Bytes                   : 0
        Total Tx Frames with DE              : 0
        Total Tx Frames with FECN            : 0
        Tx Frames with FECN Tagged Locally   : 0
        Total Tx Frames with BECN            : 0
        Tx Frames with BECN Tagged Locally   : 0
Receive Direction :
        Rx Frames                            : 0
        Rx Bytes                             : 0
        Rx Frames Discarded                  : 0
        Rx Bytes Discarded                   : 0
        Total Rx Frames with DE              : 0
        Rx Frames with DE Tagged Locally     : 0
        Total Rx Frames with FECN            : 0
        Rx Frames with FECN Tagged Locally   : 0
        Total Rx Frames with BECN            : 0
        Rx Frames with BECN Tagged Locally   : 0
Rx connection-traffic-table-index: 100
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
Tx connection-traffic-table-index: 100
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
```

The following example displays the overflow queuing configuration of VC serial interface 1/0/0:1 DLCI 201:

```
Switch# show vc interface serial 1/0/0:1 201

Interface: Serial1/0/0:1, Type: FRPAM-SERIAL
DLCI = 201     Status : ACTIVE   Peer Status : INACTIVE
Connection-type: PVC
Cast-type: point-to-point
→ Per VC Overflow Status: Enabled,
→ User Configured Option is: Enable.
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 16:00:40      Time-since-last-status-change : 16:00:29
ATM-P Interface: ATM-P1/0/0, Type: ATM-PSEUDO
ATM-P VPI = 1  ATM-P VCI = 233
ATM-P Connection Status: UP
Cross-connect-interface: Serial3/0/0:1, Type: FRPAM-SERIAL
```

```
Cross-connect-DLCI = 201
Cross-connect-UPC: tag-drop
Transmit Direction :
        Total tx Frames                    : 0
        Tota tx Bytes                      : 0
        Discarded tx Frames                : 0
        Discarded tx Bytes                 : 0
        Total Tx Frames with DE            : 0
        Total Tx Frames with FECN          : 0
        Tx Frames with FECN Tagged Locally : 0
        Total Tx Frames with BECN          : 0
        Tx Frames with BECN Tagged Locally : 0
Receive Direction :
        Rx Frames                          : 0
        Rx Bytes                           : 0
        Rx Frames Discarded                : 0
        Rx Bytes Discarded                 : 0
        Total Rx Frames with DE            : 0
        Rx Frames with DE Tagged Locally   : 0
        Total Rx Frames with FECN          : 0
        Rx Frames with FECN Tagged Locally : 0
        Total Rx Frames with BECN          : 0
        Rx Frames with BECN Tagged Locally : 0
Rx connection-traffic-table-index: 100
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
Tx connection-traffic-table-index: 100
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
```

The following example displays the overflow queuing configuration of VC serial interface 1/0/0:1 DLCI 300:

```
Switch# show vc interface serial 1/0/0:1 300

Interface: Serial1/0/0:1, Type: FRPAM-SERIAL
DLCI = 300     Status : ACTIVE   Peer Status : INACTIVE
Connection-type: PVC
Cast-type: point-to-point
→ Per VC Overflow Status: Enabled,
→ User Configured Option is: Inherit from Interface.
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 00:00:14      Time-since-last-status-change : 00:00:06
Interworking Function Type : network
de-bit Mapping : map-clp-or-de       clp-bit Mapping : map-de
ATM-P Interface: ATM-P1/0/0, Type: ATM-PSEUDO
ATM-P VPI = 1  ATM-P VCI = 332
ATM-P Connection Status: UP
Cross-connect-interface: ATM0/0/0, Type: oc3suni
Cross-connect-VPI = 3
Cross-connect-VCI = 333
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Cross-connect-UPC: pass
Transmit Direction :
        Total tx Frames                    : 0
        Tota tx Bytes                      : 0
        Discarded tx Frames                : 0
```

```
        Discarded tx Bytes                : 0
        Total Tx Frames with DE           : 0
        Total Tx Frames with FECN         : 0
        Tx Frames with FECN Tagged Locally   : 0
        Total Tx Frames with BECN         : 0
        Tx Frames with BECN Tagged Locally   : 0
Receive Direction :
        Rx Frames                         : 0
        Rx Bytes                          : 0
        Rx Frames Discarded               : 0
        Rx Bytes Discarded                : 0
        Total Rx Frames with DE           : 0
        Rx Frames with DE Tagged Locally     : 0
        Total Rx Frames with FECN         : 0
        Rx Frames with FECN Tagged Locally   : 0
        Total Rx Frames with BECN         : 0
        Rx Frames with BECN Tagged Locally   : 0
Rx connection-traffic-table-index: 100
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
Tx connection-traffic-table-index: 100
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
```

The following example confirms overflow queuing is configured on serial interface 1/1/2:1:

```
Switch# show interface serial 1/1/2:1
Serial1/1/2:1 is up, line protocol is up
➔  Interface Overflow Configuration is Enabled.
  Hardware is FRPAM-SERIAL
  MTU 4096 bytes, BW 64 Kbit, DLY 0 usec,
     reliability 255/255, txload 139/255, rxload 139/255
  Encapsulation FRAME-RELAY IETF, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  582, LMI stat recvd 582, LMI upd recvd 0, DTE LMI up
  LMI enq recvd 582, LMI stat sent  582, LMI upd sent  0, DCE LMI up
  LMI DLCI 1023  LMI type is CISCO  frame relay NNI
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input 00:00:03, output 00:00:03, output hang never
  Last clearing of "show interface" counters 01:37:51
  Input queue: 0/75/7309/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue :0/40 (size/max)
  30 second input rate 57000 bits/sec, 103 packets/sec
  30 second output rate 57000 bits/sec, 103 packets/sec
     546215 packets input, 38181611 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
     538900 packets output, 37669569 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
   Timeslots(s) Used: 1-1 on E1 2
   Frames Received with:
    DE set: 0, FECN set :0, BECN set: 0
  Frames Tagged :
    DE: 370752, FECN: 0 BECN: 0
  Frames Discarded Due to Alignment Error: 0
```

```
  Frames Discarded Due to Illegal Length: 0
  Frames Received with unknown DLCI: 0
  Frames with illegal Header : 0
  Transmit Frames with FECN set :0,  BECN Set :4175
  Transmit Frames Tagged FECN : 0 BECN : 0
  Transmit Frames Discarded due to No buffers : 0
```

The following example displays the overflow queuing configuration of serial interface 1/0/0:1:

```
Switch# show running-config interface serial 1/0/0:1
Building configuration...

Current configuration : 561 bytes
!
interface Serial1/0/0:1
 no ip address
 encapsulation frame-relay IETF
 no keepalive
 no arp frame-relay
 frame-relay intf-type nni
➔ frame-relay accept-overflow
```

The following example displays the overflow queuing configuration of VC serial interface 1/0/0:1 DLCI 555:

```
Switch# show vc interface serial 1/0/0:1 555

Interface: Serial1/0/0:1, Type: FRPAM-SERIAL
DLCI = 555     Status : ACTIVE   Peer Status : INACTIVE
Connection-type: SoftVC
Cast-type: point-to-point
➔ Per VC Overflow Status: Enabled,
➔ User Configured Option is: Enable.
Usage-Parameter-Control (UPC): tag-drop
pvc-create-time : 00:00:26      Time-since-last-status-change : 00:00:14
Interworking Function Type : network
de-bit Mapping : map-clp-or-de       clp-bit Mapping : map-de
 Soft vc location: Source
 Remote ATM address: 47.0091.8100.0000.0004.ddec.d401.4000.0c81.8010.00
 Remote DLCI : 555
 Soft vc call state: Active
 Number of soft vc re-try attempts: 0
 First-retry-interval: 5000 milliseconds
 Maximum-retry-interval: 60000 milliseconds
 Aggregate admin weight: 0
 TIME STAMPS:
 Current Slot:1
  Outgoing Setup     July 21 23:15:18.595

ATM-P Interface: ATM-P1/0/0, Type: ATM-PSEUDO
ATM-P VPI = 1  ATM-P VCI = 587
ATM-P Connection Status: UP
Cross-connect-interface: Serial3/0/0:1, Type: FRPAM-SERIAL
Cross-connect-DLCI = 555
Cross-connect-UPC: tag-drop
Transmit Direction :
        Total tx Frames                      : 0
        Tota tx Bytes                        : 0
        Discarded tx Frames                  : 0
        Discarded tx Bytes                   : 0
        Total Tx Frames with DE              : 0
        Total Tx Frames with FECN            : 0
        Tx Frames with FECN Tagged Locally   : 0
        Total Tx Frames with BECN            : 0
```

```
        Tx Frames with BECN Tagged Locally   : 0
Receive Direction :
        Rx Frames                            : 0
        Rx Bytes                             : 0
        Rx Frames Discarded                  : 0
        Rx Bytes Discarded                   : 0
        Total Rx Frames with DE              : 0
        Rx Frames with DE Tagged Locally     : 0
        Total Rx Frames with FECN            : 0
        Rx Frames with FECN Tagged Locally   : 0
        Total Rx Frames with BECN            : 0
        Rx Frames with BECN Tagged Locally   : 0
Rx connection-traffic-table-index: 100
Rx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Rx pir: 64000
Rx cir: 64000
Rx Bc : 32768
Rx Be : 32768
Tx connection-traffic-table-index: 100
Tx service-category: VBR-NRT (Non-Realtime Variable Bit Rate)
Tx pir: 64000
Tx cir: 64000
Tx Bc : 32768
Tx Be : 32768
```

The following example displays the overflow queuing configuration of serial interface 1/0/0:1:

```
Switch# show running-config interface serial 1/0/0:1
Building configuration...

Current configuration : 684 bytes
!
interface Serial1/0/0:1
 no ip address
 encapsulation frame-relay IETF
 no keepalive
 no arp frame-relay
 frame-relay intf-type nni
 frame-relay accept-overflow
→ frame-relay pvc 100 accept-overflow disable network  interface  ATM0/0/0 1 100
 frame-relay pvc 300 network  interface  ATM0/0/0 3 333
→ frame-relay soft-vc 500 accept-overflow enable dest-address
47.0091.8100.0000.0004.ddec.d401.4000.0c81.8010.00 vc 5 500
→ frame-relay soft-vc 555 accept-overflow enable dest-address
47.0091.8100.0000.0004.ddec.d401.4000.0c81.8010.00 dlci 555
→ frame-relay soft-vc 888 accept-overflow enable dest-address
→ 47.0091.8100.0000.0004.ddec.d401.4000.0c81.8010.00 dlci 888 accept-overflow disable gat
end
```

CHAPTER 21

Configuring IMA Port Adapter Interfaces

This chapter describes inverse multiplexing over ATM (IMA) and the steps required to configure the IMA port adapters in the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. These port adapters group multiple low-speed links into one larger virtual trunk or IMA group.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For hardware installation and cabling instructions, refer to the *ATM and Layer 3 Port Adapter and Interface Module Installation Guide*.

For more information on how to configure your IMA-specific network equipment, refer to the Cisco IOS publications on the Documentation CD-ROM.

This chapter includes the following sections:

Note IMA is only possible on switches with FC-PFQ installed.

Overview of IMA

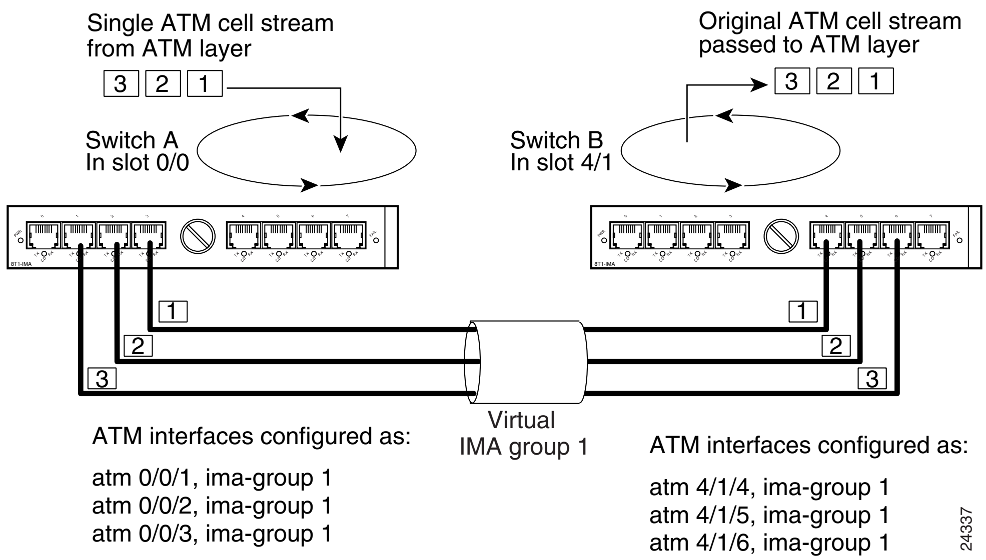
IMA allows you to aggregate multiple low-speed links into one larger virtual trunk or IMA group. An inverse multiplexer appears to your ATM switch router as one logical pipe. This IMA group provides modular bandwidth for user access to ATM networks for connections between ATM network elements at rates between the traditional order multiplex levels, such as between T1 or E1 and T3 or E3.

IMA involves inverse multiplexing and demultiplexing of ATM cells in a cyclical fashion among links grouped to form a higher bandwidth logical group with a rate approximately the sum of the link rates. This group of links is called an IMA group.

Inverse multiplexing in the transmit direction controls the distribution of cells onto the group of physical links available to the IMA group interface. It also handles differential delays and deals with links that are added or dropped, or fail and are later restored. In the receive direction, the IMA interface performs differential delay compensation and recombines the cells into the original ATM cell stream while allowing minimal cell delay variation (CDV). The IMA process of splitting and recombining the ATM cell stream is as transparent to the layer above as a traditional single-link physical layer interface.

Figure 21-1 illustrates the configuration of the T1 IMA port adapters (with eight ports each) on two switches which create a virtual IMA group connection.

Figure 21-1 IMA Grouping Example



IMA groups terminate at each end of the IMA virtual link. The transmit IMA receives the ATM cell stream from the ATM layer and distributes it on a cell-by-cell basis across the multiple T1 or E1 links within the IMA group. At the far-end, the receiving IMA recombines the cells from each link, also on a cell-by-cell basis, recreating the original ATM cell stream. The aggregate cell stream is then passed to the ATM layer.

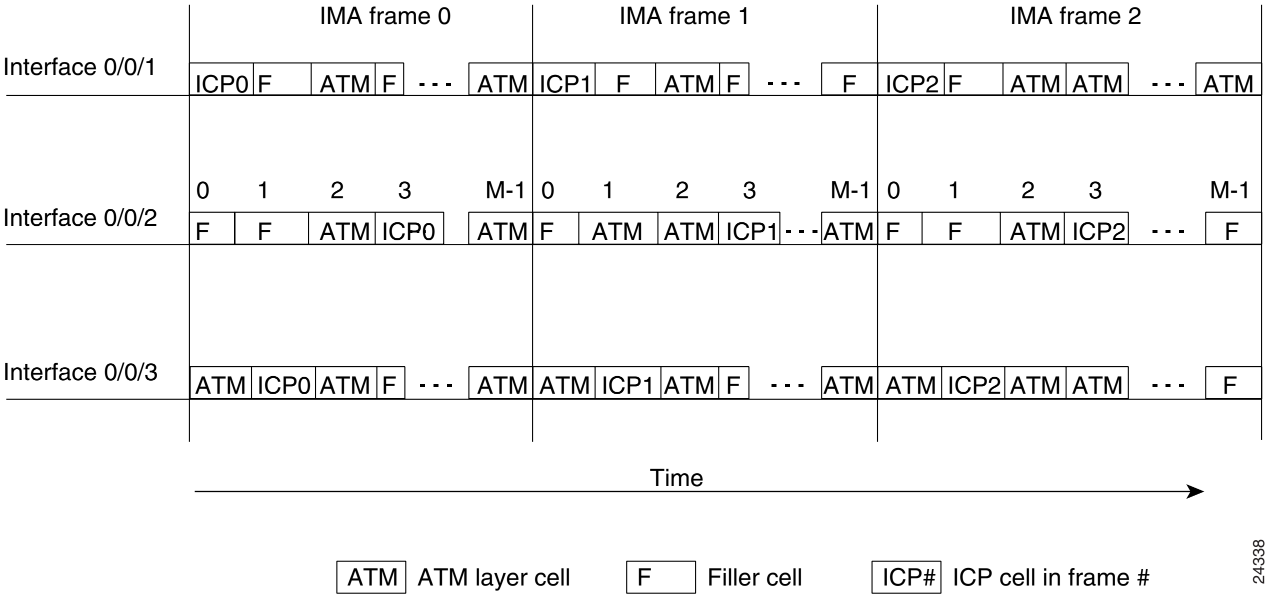
The IMA frame is the unit of control in the IMA protocol. An IMA frame is a series of consecutive cells. Periodically, the transmit IMA sends special cells that permit reconstruction of the ATM cell stream at the receiving IMA. These cells, defined as IMA Control Protocol (ICP) cells, provide the definition of an IMA frame. The transmitter must align the transmission of IMA frames on all links (shown in Figure 21-2) to allow the receiver to adjust for differential link delays among the constituent physical links. Based on this required behavior, the receiver can detect the differential delays by measuring the arrival times of the IMA frames on each link.

The transmitting end sends cells continuously. If no ATM layer cells are sent between ICP cells within an IMA frame, the transmit IMA sends filler cells to maintain a continuous stream of cells at the physical layer. Filler cells, which provide cell rate decoupling at the IMA sublayer, are discarded by the receiving IMA.

A new OAM cell is defined for use by the IMA protocol. This cell has codes that define it as either an ICP cell or a filler cell.

Within the IMA frame, the ICP cell appears at the ICP cell offset position, which can vary among the links. Figure 21-2 shows an example of the transmission of IMA frames over three links. On interface 0/0/1, the ICP cells have their cell offset set to 0 and are the first cells in each IMA frame. On interface 0/0/2, the ICP cells have the ICP cell offset set to 3 and are the fourth cells in each IMA frame. On interface 0/0/3, the ICP cells have their ICP cell offset set to 1 and are the second cells in each IMA frame.

Figure 21-2 IMA Frames



Note These ICP cells are distributed more evenly over the IMA frame but are shown closer for illustration purposes. Within an IMA frame, the ICP cells on all links have the same IMA frame sequence number.

Configuring the T1/E1 IMA Port Adapter

The T1/E1 IMA port adapter provides eight physical ports. Each port adapter supports up to four IMA groups and independent ATM interfaces. The following are possible combinations:

- Four IMA groups
- Three IMA groups and one independent ATM interface
- Two IMA groups and two independent ATM interfaces
- One IMA group and three independent ATM interfaces
- No IMA group and four independent ATM interfaces

The T1 line operates at 1.544 Mbps, which is equivalent to 24 time slots (DS0 channels). The T1 time slot provides usable bandwidth of *n* x 64 kbps, where *n* is the time slot from 1 to 24. The E1 line operates at 2.048 Mbps.

T1/E1 IMA port adapters support interface overbooking. For configuration information, see Chapter 9, "Configuring Resource Management."

Note By default, T1/E1 IMA interfaces are shut down when the port adapter is installed.

Default T1/E1 IMA Interface Configuration

The following defaults are assigned to all T1/E1 IMA port adapter interfaces:

- Clock source = system clock
- Transmit clock source = network derived
- Loopback = no loopback
- BERT = disabled

The following port adapter types have specific defaults assigned.

T1 port adapter:

- Framing = extended super frame (ESF)
- Line build-out (LBO) = short 133
- Linecode = b8zs
- Facilities Data Link (FDL) = no FDL
- Yellow = enabled

E1 port adapter:

- Framing = pcm30adm
- Line build-out (LBO) = short gain12 22db
- Linecode = hdb3
- National bits = 1 1 1 1 1 1

The following defaults are assigned to all IMA groups:

- Minimum number of active links = 1
- Clock mode = common
- Differential delay = 25 milliseconds
- Frame length = 128 cells
- Test link = first link in the group
- Test pattern = value of test link

Configuring the T1/E1 IMA Interface

To manually change any of your default configuration values, perform the following steps, beginning in global configuration mode:

Note IMA is only possible on switches with FC-PFQ installed.

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Specifies the ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **bert pattern** {**2^15** | **2^20** | **2^23** | **0s** | **1s** | **2^11** | **2^20-QRSS** | **alt-0-1**} **interval** *minutes*	Configures the bit error rate test pattern.

	Command	Purpose
Step 3	Switch(config-if)# **clock source** {**free-running** | **loop-timed** | **network-derived**}	Configures the type of clocking.
Step 4	Switch(config-if)# **framing** {**esfadm** | **sfadm**}	Modifies the T1 IMA framing type.
	Switch(config-if)# **framing** {**cleare1** | **crc4adm** | **pcm30adm**}	Modifies the E1 IMA framing type.
Step 5	Switch(config-if)# **lbo** {**long** {**gain26** | **gain36**} {**-15db** | **-22.5db** | **-7.5db** | **0db**}} | {**short** {**133ft** | **266ft** | **399ft** | **533ft** | **655ft**}}	Modifies the T1IMA line build-out.
	Switch(config-if)# **lbo** {**long gain43** {**120db** | **75db**} | **short gain12 22db**}	Modifies the E1 IMA line build-out.
Step 6	Switch(config-if)# **loopback** {**cell** | **diagnostic** | **line** | **local** | **payload** | **pif** | **remote** {**line** {**inband** | **fdl** {**ansi** | **bellcore**}} | **payload** [**fdl ansi**]}}	Configures the T1 line loopback.
	Switch(config-if)# **loopback** {**cell** | **diagnostic** | **line** | **payload** | **pif**}	Configures the E1 line loopback.
Step 7	Switch(config-if)# **linecode** {**ami** | **b8zs**}	Modifies the T1 line code format.
	Switch(config-if)# **linecode** {**ami** | **hdb3**}	Modifies the E1 line code format.
Step 8	Switch(config-if)# **fdl** {**ansi** | **att**}	Configures T1 FDL format.
Step 9	Switch(config-if)# **yellow** {**detection** | **generation**}	Enables T1 yellow alarm detection.
Step 10	Switch(config-if)# **national reserve** *bit-pattern*	Modifies the E1 national bits.

Example

The following example shows how to change the clock source to free running:

```
Switch(config)# interface atm 0/0/3
Switch(config-if)# clock source free-running
```

Displaying the T1/E1 IMA Interface Configuration

To display the physical T1/E1 IMA interface configuration, use the following EXEC command:

Command	Purpose
show controllers atm *card/subcard/port*	Displays the physical interface configuration and status.

Example

The following example shows a T1 IMA ATM interface 0/0/3 configuration, including the change to the clock source configuration from the previous section:

```
Switch# show controller atm 0/0/3
ATM0/0/3 is up
        PAM State is UP
        Firmware Version: 1.6
        FPGA Version : 1.2
        Boot version : 1.2
Port type: T1    Port rate: 1.5 Mbps    Port medium: UTP
```

```
  Port status:Good Signal    Loopback:None    Flags:8000
  fdl is DISABLED
  Yellow alarm enabled in both tx and rx
  linecode is B8ZS
  TX Led: Traffic Pattern    RX Led: Traffic Pattern   CD Led: Green
➔ TX clock source:  free-running
  T1 Framing Mode:  ESF ADM format
  LBO (Cablelength) is short 133
  Counters:
      Key: txcell   - # cells transmitted
         rxcell     - # cells received
         hcs        - # uncorrectable HEC errors
         chece      - # rx Correctable HEC errors
         uicell     - # unassigned/idle cells dropped
         oocd       - # rx out of cell deliniation
         rx_fovr    - # rx FIFO over run
         tx_fovr    - # tx FIFO over run
         coca       - # tx Change of cell allignment
         pcv        - # path code violations
         lcv        - # line code violations
         es         - #
  --More--
```

Configuring IMA Group Functions

To configure IMA group functions on an ATM switch router, perform the tasks in the following sections:

- Creating an IMA Group Interface, page 21-6
- Adding an Interface to an Existing IMA Group, page 21-8
- Deleting an Interface from an IMA Group, page 21-10
- Deleting an IMA Group, page 21-11

Creating an IMA Group Interface

To create an IMA group interface, first link a physical interface to the IMA group. After configuring the physical interface as part of an IMA group, you can then create the IMA group interface. An IMA group interface is identified by its card, subcard, and IMA group number. For example, IMA group 1 configured on the physical interface card 0 and subcard 0 is identified as 0/0/ima1. IMA group numbers range from 0 to 3.

Note You must create the IMA group at both ends of the connection.

To create an IMA group interface at both ends of the connection, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies the ATM port and enters interface configuration mode.
Step 2	Switch(config-if)# **shutdown**	Shuts down the interface prior to configuring the IMA group.

	Command	Purpose
Step 3	Switch(config-if)# **ima-group** *number*	Assigns the interface to an IMA group number.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.
Step 5	Switch(config-if)# **exit** Switch(config)#	Returns to global configuration mode.
Step 6	Switch(config)# **interface atm** *card***/***subcard***/ima***group* Switch(config-if)#	Specifies the IMA group 0 to 3 and enters interface configuration mode.
Step 7	Switch(config-if)# **no shutdown**	Creates the IMA group.
Step 8	—	Repeat this procedure on the other end of the connection.

Note The IMA group numbers on each end of the interface can differ. For example, you can configure the interfaces in IMA group 1 on Switch A and in IMA group 2 on Switch B.

Example

The following example shows how to create the IMA group interface 0/0/ima1 shown in Figure 21-1 starting with Switch A, ATM interface 0/0/1:

```
SwitchA(config)# interface atm 0/0/1
SwitchA(config-if)# shutdown
SwitchA(config-if)# ima-group 1
SwitchA(config-if)# no shutdown
SwitchA(config-if)# exit
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# no shutdown
```

The following example shows how to create the IMA group interface 4/1/ima1 shown in Figure 21-1 on Switch B, ATM interface 4/1/4:

```
SwitchB(config)# interface atm 4/1/4
SwitchB(config-if)# shutdown
SwitchB(config-if)# ima-group 1
SwitchB(config-if)# no shutdown
SwitchB(config-if)# exit
SwitchB(config)# interface atm 4/1/ima1
SwitchB(config-if)# no shutdown
```

Adding an Interface to an Existing IMA Group

An interface can be added to an existing IMA group link by assigning the IMA group number.

Note You must configure the IMA group at both ends of the physical connection.

To configure the interfaces at both ends of the connection as members of an existing IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies the ATM port and enters interface configuration mode.
Step 2	Switch(config-if)# **shutdown**	Prior to configuring the IMA group, shuts down the interface.
Step 3	Switch(config-if)# **ima-group** *number*	Assigns the interface to an IMA group number.
Step 4	Switch(config-if)# **no shutdown**	Reenables the interface.
Step 5	—	Repeat this procedure on the other end of the connection.

Note You can use the **ima-group** command to move an interface from one IMA group to another.

Examples

The following example shows how to configure ATM interface 0/0/2 on Switch A as part of the IMA group 1 shown in Figure 21-1:

```
SwitchA(config)# interface atm 0/0/2
SwitchA(config-if)# shutdown
SwitchA(config-if)# ima-group 1
SwitchA(config-if)# no shutdown
```

The following example shows how to configure ATM interface 4/1/5 on Switch B as part of the IMA group 1 shown in Figure 21-1:

```
SwitchB(config)# interface atm 4/1/5
SwitchB(config-if)# shutdown
SwitchB(config-if)# ima-group 1
SwitchB(config-if)# no shutdown
```

The following example shows how to move ATM interface 4/1/5 on Switch B to the IMA group 3:

```
SwitchB(config)# interface atm 4/1/5
SwitchA(config-if)# shutdown
SwitchB(config-if)# ima-group 3
SwitchB(config-if)# no shutdown
```

Displaying the IMA Group Configuration

To display the IMA group configuration, use the following EXEC commands:

Command	Purpose
show ima interface [**atm** *card*/*subcard*/**ima***group* [**detailed**]]	Displays IMA group interface configuration and status.
show interfaces atm *card*/*subcard*/**ima***group*	Displays IMA interface configuration and status.

Example

The following example shows the IMA group interface configuration for IMA group 0/0/ima1 interface:

```
SwitchA# show ima interface atm 0/0/ima1
ATM0/0/ima1 is up
        Group Index    = 2
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
        DiffDelayMax  = 25   FrameLength   = 128
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/3
        TestLink      = 3       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 990426154350
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------      ---------------
ATM0/0/2       up                     active                 disabled
ATM0/0/3       up                     active                 disabled
```

The following example shows the interface configuration for T1 IMA group 0/0/ima1:

```
SwitchA# show interfaces atm 0/0/ima1
ATM0/0/ima1 is up, line protocol is up
  Hardware is imapam_t1_ima
  MTU 4470 bytes, sub MTU 4470, BW 1500 Kbit, DLY 0 usec, rely 255/255, load 1/255
  Encapsulation ATM, loopback not set, keepalive not supported
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/0/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     223 packets input, 11819 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
     215 packets output, 11395 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

The following example shows the ATM layer interface configuration of the T1 IMA group 0/0/ima1:

```
SwitchA# show atm interface atm 0/0/ima1

Interface:      ATM0/0/ima1     Port-type:      imapam_t1_ima
IF Status:      UP              Admin Status:   up
```

```
Auto-config:    enabled         AutoCfgState:   completed
IF-Side:        Network         IF-type:        NNI
Uni-type:       not applicable  Uni-version:    not applicable
Max-VPI-bits:   8               Max-VCI-bits:   14
Max-VP:         255             Max-VC:         16383
ConfMaxSvpcVpi: 255             CurrMaxSvpcVpi: 255
ConfMaxSvccVpi: 255             CurrMaxSvccVpi: 255
ConfMinSvccVci: 35              CurrMinSvccVci: 35
Svc Upc Intent: pass            Signalling:     Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0040.0b0a.2a81.4000.0c80.0090.00
Configured virtual links:
  PVCLs SoftVCLs   SVCLs   TVCLs   PVPLs SoftVPLs   SVPLs Total-Cfgd Inst-Conns
      3        0       0       0       0        0       0          3          3
Logical ports(VP-tunnels):     0
Input cells:    105             Output cells:   109
5 minute input rate:             0 bits/sec,       0 cells/sec
5 minute output rate:            0 bits/sec,       0 cells/sec
Input AAL5 pkts: 58, Output AAL5 pkts: 60, AAL5 crc errors: 0
```

Deleting an Interface from an IMA Group

To delete an interface from an IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Specifies the ATM port and enters interface configuration mode.
Step 2	Switch(config-if)# **no ima-group**	Deleted the interface from an IMA group number.

Example

The following example shows how to delete an interface from an IMA group:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# no ima-group
```

Confirming the Interface Deletion

To confirm the interface deletion from the IMA group, use the following EXEC command:

Command	Purpose
show ima interface atm *card***/***subcard***/***port*	Displays IMA group interface configuration and status.

Example:

The following example shows how to verify that the interface is deleted from the IMA group:

```
SwitchA# show ima interface atm 0/0/1
ATM0/0/1 is not a part of IMA group
```

Deleting an IMA Group

To delete an IMA group, use the following global configuration command:

Command	Purpose
no interface atm *card***/***subcard***/ima***group*	Deletes the IMA group from the T1/E1 IMA interface.

Note When you delete an IMA group, the interfaces remain configured as members of the IMA group. When you recreate the IMA group, the member interfaces reinitialize automatically.

Example

The following example shows how to delete ATM interface 0/0/ima1 and administratively shut down the member interfaces:

```
Switch(config)# no interface atm 0/0/ima1
```

Confirming the IMA Group Deletion

To confirm the IMA group deletion, perform the following steps in user EXEC mode:

Command	Purpose
show ima interface [**atm** *card***/***subcard***/ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows how to verify that the interface is deleted from the IMA group:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/2
Switch(config-if)# shut
```

```
Switch(config-if)# ima-group 0
Switch(config-if)# no shut
Switch(config-if)# exit
Switch(config)# interface atm 0/0/ima0
Switch(config-if)# no shut
Switch(config-if)# end
Switch# show ima interface atm 0/0/ima0
ATM0/0/ima0 is up
        Group Index    = 5
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
        DiffDelayMax  = 25   FrameLength   = 128
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/2
        TestLink      = 2       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 000210165420
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------      ---------------
ATM0/0/2       up                     active                 disabled
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface atm 0/0/ima0
Switch(config-if)# end
Switch(config)# no interface atm 0/0/ima0
Switch(config)# exit
Switch# show ima interface atm 0/0/ima0
                           ^
% Invalid input detected at '^' marker.

Switch#
```

Configuring IMA Group Parameters

This section describes how to configure inverse multiplexing over ATM (IMA) group parameters after configuring an IMA group at the interface level. These tasks include configuring active minimum links, interface clock mode, link differential delay, frame length, and test pattern.

Configuring IMA Group Minimum Active Links

You can configure an IMA group to require a minimum number of active links. This number is the minimum number of links required for the IMA group to become operational and provides a guaranteed minimum bandwidth. For example, if the **active-minimum-links** command number is configured as 3, the minimum number of active links necessary for the IMA group to be active is three and the minimum bandwidth available is approximately 3 x T1 speed.

To configure the minimum active links on the IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/**ima***group* Switch(config-if)#	Specifies the IMA group to configure and enters interface configuration mode.
Step 2	Switch(config-if)# **ima active-links-minimum** *number*	Specifies the minimum number of active links for an IMA group.

Note Only when the minimum number of links are active in the IMA group does the group come up. The IMA group remains down if the IMA group has fewer active links than the minimum number of active links configured.

Example

The following example shows how to configure the minimum number of active links that must be up for the IMA group to function as 3:

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# ima active-links-minimum 3
```

Displaying the IMA Group Minimum Active Links Configuration

To display the IMA group minimum active links configuration, use the following EXEC command:

Command	Purpose
show ima interface [**atm** *card*/*subcard*/**ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows the IMA group interface minimum active links configuration:

```
SwitchA# show ima interface
ATM0/0/ima1 is up
        Group Index    = 5
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
➔        MinNumTxLinks = 3   MinNumRxLinks = 3
        DiffDelayMax  = 25   FrameLength   = 128
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/2
        TestLink      = 2       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 990427165502
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------      ---------------
ATM0/0/2       up                     active                 disabled
ATM0/0/3       up                     active                 disabled
ATM0/0/4       up                     active                 disabled
ATM0/0/5       up                     active                 disabled
```

Configuring IMA Group Interface Clock Mode

The links configured as part of a IMA group interface can derive their clocking from one single clock source using common transmit clocking (CTC) mode, or the link clocking can be derived individually from different clock sources using independent transmit clocking (ITC) mode. For example, if three interfaces are configured as members of an IMA group interface, one can be configured to use the reference clock, and the remaining links can derive their clocking from the local oscillator.

To configure the clocking mode on the IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/**ima***group* Switch(config-if)#	Specifies the IMA group to configure and enters interface configuration mode.
Step 2	Switch(config-if)# **ima clock-mode** {**common** | **independent**}	Specifies the transmit clock mode for the IMA group.

Example

The following example shows how to configure the IMA group clocking mode as independent:

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# ima clock-mode independent
```

Displaying the IMA Group Interface Clock Mode Configuration

To display the IMA group transmit clock mode configuration, use the following EXEC command:

Command	Purpose
show ima interface [**atm** *card*/*subcard*/**ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows the IMA group clock mode configuration:

```
SwitchA# show ima interface
ATM0/0/ima1 is up
        Group Index    = 4
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
        DiffDelayMax  = 25   FrameLength   = 128
➔       NeTxClkMode   = independent(itc)
        TestLink      = 3       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 990427121150
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------      ---------------
ATM0/0/2       up                     active                 disabled
ATM0/0/3       up                     active                 disabled
```

Configuring IMA Group Link Differential Delay

The transmitter on the T1/E1 IMA port adapter must align the transmission of IMA frames on all links as shown in Figure 21-2. Alignment allows the receiver to adjust for differential delays among the members of the IMA group. Based on this required behavior, the receiver can detect the differential delays by measuring the arrival times of the IMA frames on each link.

The transmitting end of the IMA group connection sends cells continuously. If there are no ATM layer cells to send between ICP cells within an IMA frame, the transmit IMA sends filler cells to maintain a continuous stream of cells at the physical layer.

The receiving end of the IMA group connection must allocate sufficient buffer space to compensate for the differential delay between the member links. The maximum differential delay value configured for the IMA group determines the size of these buffers.

To configure the maximum differential delay allowed in the IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/**ima***group* Switch(config-if)#	Specifies the IMA group and enters interface configuration mode.
Step 2	Switch(config-if)# **ima differential-delay-maximum** *msecs*	Specifies the maximum link differential delay tolerated for the IMA group in milliseconds. For T1, the range is 25 to 250 milliseconds, and for E1, the range is 25 to 190 milliseconds.

Example

The following example shows how to configure the maximum allowable differential delay to 100 milliseconds between all interfaces assigned to the IMA group.

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# ima differential-delay-maximum 100
```

Displaying the IMA Group Link Differential Delay Configuration

To display the IMA group maximum differential delay configuration, use the following EXEC command:

Command	Purpose
show ima interface [**atm** *card***/***subcard***/ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows the IMA group maximum differential delay configuration:

```
SwitchA# show ima interface
ATM0/0/ima1 is up
        Group Index    = 4
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
➔        DiffDelayMax  = 100  FrameLength   = 128
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/3
        TestLink      = 3       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 990427135611
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------      ---------------
ATM0/0/2       up                     active                 disabled
ATM0/0/3       up                     active                 disabled
```

Configuring IMA Group Frame Length

The IMA protocol uses the frame length parameter to determine the number of cells that make up an IMA frame.The IMA group frame length determines the amount of framing overhead and the amount of data lost in case of frame corruption or loss. A small frame length causes more overhead but loses less data if a problem occurs. The recommended frame length is 128.

To configure the frame length on the IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/ima***group* Switch(config-if)#	Specifies the IMA group to configure and enters interface configuration mode.
Step 2	Switch(config-if)# **ima frame-length** {**128** | **256** | **32** | **64**}	Specifies the frame length of the IMA group transmit frames, in number of cells.

Example

The following example shows how to configure the frame length transmitted as 256 cells for IMA group 0/0/ima1:

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# ima frame-length 256
```

Displaying the IMA Group Frame Length Configuration

To display the IMA group frame length configuration, use the following EXEC command:

Command	Purpose
show ima interface [**atm** *card*/*subcard*/**ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows the IMA group frame length configuration:

```
SwitchA# show ima interface
ATM0/0/ima1 is up
        Group Index    = 4
        State: NearEnd = operational, FarEnd = operational
        FailureStatus = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
➔        DiffDelayMax  = 25   FrameLength   = 256
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/3
        TestLink      = 3       Testpattern      = Not Specified
        TestProcStatus     = disabled   GTSM change timestamp = 990427143739
IMA Link Information:
Link          Physical Status        NearEnd Rx Status       Test Status
-----         ---------------        -----------------      ---------------
ATM0/0/2      up                     active                 disabled
ATM0/0/3      up                     active                 disabled
```

Configuring IMA Group Test Pattern

An IMA group can have a test pattern defined to provide extra support to verify the connectivity of links within an IMA group. It uses a test pattern sent over one link to verify connectivity to the rest of the group. The test pattern should be looped over all the other links in the group at the far end of the connection. The test procedure is performed using the ICP cells exchanged between both ends of the IMA virtual links.

To configure the test pattern to be transmitted on the IMA group, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/**ima***group* Switch(config-if)#	Specifies the IMA group and enters interface configuration mode.

	Command	Purpose
Step 2	Switch(config-if)# **ima test** [**link** *link-value*] [**pattern** *pattern-value*]	Specifies the specific link and pattern or test pattern only for the IMA group.
Step 3	Switch(config-if)# **no ima test**	Stops the test on the IMA group.

Examples

The following example shows how to configure the test pattern 8 to transmit over link 3 of IMA group 0/0/ima1:

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# ima test link 3 pattern 8
```

The following example shows how to stop the test on IMA group 0/0/ima1:

```
SwitchA(config)# interface atm 0/0/ima1
SwitchA(config-if)# no ima test
```

Displaying the IMA Group Test Pattern Configuration

To display the IMA group test pattern configuration, use the following EXEC command:

Command	Purpose
show ima interface [**atm** *card*/*subcard*/**ima***group* [**detailed**]]	Displays IMA group interface configuration and status.

Example

The following example shows the IMA group test pattern configuration:

```
SwitchA# show ima interface
ATM0/0/ima1 is up
        Group Index    = 4
        State: NearEnd = operational, FarEnd = operational
        FailureStatus  = noFailure
IMA Group Current Configuration:
        MinNumTxLinks = 1    MinNumRxLinks = 1
        DiffDelayMax  = 25   FrameLength   = 128
        NeTxClkMode   = common(ctc)  CTC_Reference_Link = ATM0/0/3
→       TestLink      = 3    TestPattern   = 8
        TestProcStatus     = operating  GTSM change timestamp = 990427143950
IMA Link Information:
Link           Physical Status        NearEnd Rx Status       Test Status
-----          ---------------        -----------------       ---------------
ATM0/0/2       up                     active                 operating
ATM0/0/3       up                     active                 operating
```

Configuring Quality of Service

This chapter describes the quality of service (QoS) features built into your switch router and includes information on how to configure the QoS functionality. This chapter includes the following sections:

Note Unless otherwise noted, the information in this chapter applies to the Catalyst 8540 CSR, Catalyst 8510 CSR, and Catalyst 8540 MSR with Layer 3 functionality. For further information about the commands used in this chapter, refer to the *ATM and Layer 3 Switch Router Command Reference*.

About Quality of Service

QoS refers to the capability of a network to provide better service to selected network traffic over various technologies, including Frame Relay, Asynchronous Transfer Mode (ATM), Ethernet and 802.1 networks, SONET, and IP-routed networks that may use any or all of these underlying technologies.The following sections describe the Best-Effort, Integrated, and Differentiated service models that the QoS functionality offers.

Note For more information about Policy Based Routing, refer to the *Layer 3 Switching Software and Feature Configuration Guide.*

Best-Effort Service

Best effort is a single service model in which an application sends data whenever it must, in any quantity, and without requesting permission or first informing the network. For best-effort service, the network delivers data if it can, without any assurance of reliability, delay bounds, or throughput.

The Cisco IOS QoS feature that implements best-effort service is first-in, first-out (FIFO) queueing. Best-effort service is suitable for a wide range of network applications such as general file transfers or e-mail.

Integrated Service

Integrated service is a multiple service model that can accommodate multiple QoS requirements. In this model the application requests a specific kind of service from the network before it sends data. Explicit signalling makes the request. The application informs the network of its traffic profile and requests a particular kind of service that can encompass its bandwidth and delay requirements. The application is expected to send data only after it gets a confirmation from the network. It is also expected to send data that lies within its described traffic profile.

The network performs admission control, based on information from the application and available network resources. It also commits to meeting the QoS requirements of the application as long as the traffic remains within the profile specifications. The network fulfills its commitment by maintaining per-flow state and then performing packet classification, policing, and intelligent queueing based on that state.

Differentiated Service

Differentiated service is a multiple service model that can satisfy differing QoS requirements. However, unlike the integrated service model, an application using differentiated service does not explicitly signal the router before sending data.

For differentiated service, the network tries to deliver a particular kind of service based on the QoS specified by each packet. This specification occurs in different ways, for example, while using the IP Precedence bit settings in IP packets or source and destination addresses. The network uses the QoS specification to classify, mark, shape, and police traffic, and to perform intelligent queueing.

About Layer 3 Switching Quality of Service

Layer 3 switching on the Catalyst 8500 switch router uses the packet classification feature in QoS to partition network traffic into multiple priority levels of classes of service. For example, by using the three precedence bits in the type-of-service (ToS) field of the IP packet header—two of the values are reserved for other purposes—you can categorize packets into a limited set of up to six traffic classes.

After you classify packets, you can utilize other QOS features to assign the appropriate traffic handling policies like congestion management and bandwidth allocation for each traffic class.

About Quality of Service Mechanisms

The Catalyst 8540 campus switch router provides extensive core Quality of Service (QoS) mechanisms that are built into the switch router architecture. These functions ensure policy enforcement and queuing of the ingress port, as well as weighted round-robin (WRR) scheduling at the egress port.

The two mechanisms discussed here are:

- IP precedence based Class of Service (CoS)

  This is used when the ingress or the egress interface is an EPIF based interface or when the egress interface is an XPIF based interface without a configured IP QoS output policy.

- IP QoS (for the Enhanced Gigabit Ethernet interfaces)

  IP QoS is the implementation of the Differentiated Services (DiffServ) model. It is used when the ingress and egress interfaces are enhanced Gigabit Ethernet interfaces, and the egress interface has an attached IP QoS output policy.

IP Precedence Based Class of Service (CoS)

Layer 3 precedence based CoS uses the IP precedence values to partition traffic into multiple classes of service.

The system gathers IP precedence information from the IP header type-of-service field. For an incoming IP packet, the first two (most significant) bits of the service type field determine the delay priority. Layer 3 switching recognizes four QoS classes, Q-0 to Q-3, as summarized in Table 22-1.

Table 22-1 QoS Delay Priorities and Queues

IP Precedence Bits	Delay Priority	Queue Selected
0 0 0	0 0	Q-0
0 0 1	0 0	Q-0
0 1 0	0 1	Q-1
0 1 1	0 1	Q-1
1 0 0	1 0	Q-2
1 0 1	1 0	Q-2
1 1 0	1 1	Q-3
1 1 1	1 1	Q-3

Your switch router can read the precedence field and switch the packet accordingly, but it cannot reclassify traffic. The edge router or switch is expected to set the precedence field according to its local policy.

The switch router queues packets based on the delay priority and the target next-hop interface.

About Scheduling and Weighted Round-Robin

Frame scheduling becomes increasingly important when an outgoing interface is congested. To handle this situation, network administrators can assign weights to each of the different queues. This provides bandwidth to higher priority applications (using IP precedence), while also granting fair access to lower priority queues. The frame schedule affords each queue the bandwidth allotted to it by the network administrator. This mapping is configurable both at the system and interface levels (as described later in this chapter).

The four queues between any pair of interfaces are configured to be part of the same service class. Bandwidth is not explicitly reserved for these four queues. Each of them is assigned a different WRR-scheduling weight, which determines the way they share the interface bandwidth. The WRR weight is user configurable; you can assign a different WRR weight for each queue.

Tip The higher the WRR weight, the higher the effective bandwidth for that particular queue.

You can find the effective bandwidth (in Mbps) for a particular queue with the following formula:

$(W/S) \times B = n$ Mbps,

where

W = WRR weight of the specified queue
S = sum of the weight of all active queues on the outgoing interface
B = available bandwidth in Mbps
n = effective bandwidth in Mbps

For example, if W is 4, S is 15, and B is 100, the formula would be (4/15) x 100 = 26 Mbps, and the effective bandwidth for the specified queue in this example is 26 Mbps.

Configuring Precedence to WRR Scheduling

This section describes the Cisco IOS commands necessary to configure QoS mapping at the system and interface levels. The commands described in this section are unique to the Layer 3 switching software.

Layer 3 switching software enables QoS-based forwarding by default.

To configure QoS scheduling at the system level, use the following command:

Command	Purpose
Router(config)# **qos mapping precedence** *value* **wrr-weight** *weight*	Sets the mapping between IP precedence and the WRR weight.

To set the precedence back to the default setting for the switch router, use the **no** version of the **qos mapping precedence** command.

Table 22-2 shows the default WRR weights for IP precedence.

Table 22-2 IP Precedence and Default WRR Weights

IP Precedence	WRR Weight
0	1
1	2
2	4
3	8

For a complete description of the **qos mapping precedence** command, see the *ATM and Layer 3 Switch Router Command Reference*.

Mapping QoS Scheduling at the Interface Level

Configuring the QoS mapping at the interface level overrides the system-level mapping. Using the **qos mapping precedence wrr-weight** command, the network administrator can assign different WRR-scheduling weights for a particular precedence traffic between a pair of interfaces.

To configure QoS scheduling at the interface level, use the following command:

Command	Purpose
Router(config)# **qos mapping** [**source** *source-interface*] [**destination** *dest-interface*] **precedence** *value* **wrr-weight** *weight*	Assigns different WRR-scheduling weights for a particular precedence traffic between a pair of interfaces.

The QoS commands are applicable to both Gigabit Ethernet and Fast Ethernet interfaces.

To set the precedence back to the system-level default setting for the switch router, use the **no** version of the **qos mapping precedence wrr-weight** command.

Both the source and destination interface parameters are optional. When both are not specified, the system-level QoS mapping is configured. Otherwise, you can specify the source interface, the destination interface, or both, to configure the WRR weight for the traffic streams listed below.

The configuration takes precedence in the following order:

1. Traffic streams with a certain precedence, from a particular source interface to a particular destination interface
2. Traffic streams with a certain precedence to a particular destination interface
3. Traffic streams with a certain precedence from a particular source interface

Verifying the QoS Configuration

To verify the QoS configuration, use the following commands:

Command	Purpose
show qos switching	Displays whether QoS-based switching is enabled.
show qos mapping [**source** *source-interface*] [**destination** *dest-interface*]	Displays effective mapping at either the system level or interface-pair level.

About IP QoS on the Enhanced Gigabit Ethernet and Enhanced ATM Router Module Interfaces

DiffServ is a mechanism by which network service providers offer differing levels of network service to different traffic classes in order to provide QoS to users.

Note The IP QoS feature is only applicable for enhanced Gigabit Ethernet and enhanced ATM Router Modules installed in the Catalyst 8540 MSR chassis.

In a DiffServ network, routers, within the network handle packets on different traffic flows by applying different per-hop behaviors (PHBs). The PHB to be applied is signalled in-band, and is specified by a DiffServ code-point (DSCP) in the IP header of each packet. No explicit out-of-band signalling protocol such as RSVP is used. Per-hop behaviors are defined to configure granular allocation of bandwidth and resource buffering at each node. Per-flow or per-user forwarding state is not maintained within each node of network. The advantage of such a scheme is that many traffic flows can be aggregated to one of a small number of PHBs, simplifying the processing requirement on each router.

The following components are the building block in the Catalyst 8540 Differentiated Services implementation:

Packet Classification

Traffic Conditioning

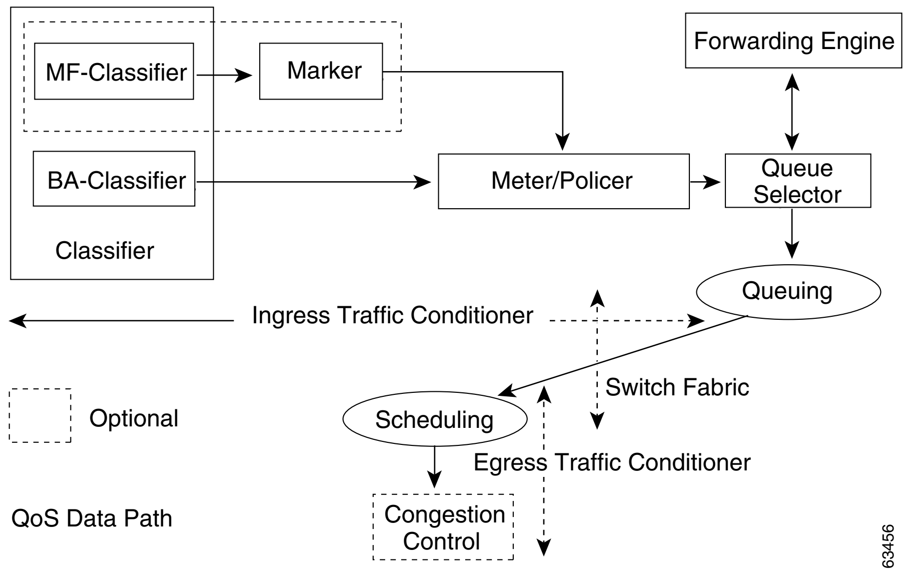
- Marking
- Metering and Policing

Per hop behavior (PHB) definition

- Congestion control
- Queueing, scheduling, buffer management

Figure 22-1 shows all the DiffServ components and their distribution between the ingress and egress points in the forwarding path.

Figure 22-1 Architectural Model



Packet Classification

Packet classifiers select packets in a traffic stream based on the content of some portion of the packet header.

Classifiers are implemented in a ternary content addressable memory (TCAM). TCAM has the capability of providing variable length matches. The order in which classifiers are defined within a policy map is the order in which entries will be programmed in TCAM.

There are two types of classifiers:

Multi-field (MF) classifiers:

- Classify traffic streams identified by the source and/or destination IP addresses, TCP/UDP source and/or destination ports, and/or Layer 4 protocol
- Are configured using one or more IP standard or extended, named or numbered Access Control Lists (ACLs)

Behavior Aggregate (BA) classifiers:

- Classify traffic streams based on the differentiated services code-point (DSCP) or IP precedence bits in the TOS byte of the IP header

Note In the IP QoS context, the permit and deny actions in the access control entries (ACEs) have different meanings than with security ACLs:

- If a match with a permit action is encountered (first-match principle), the specified traffic conditioning action for that classifier is taken.
- If a match with a deny action is encountered, the classifier being processed is skipped, and the next classifier's ACL(s) is/are processed.

- If no match with a permit action is encountered and all the configured classifiers' ACEs have been examined, the packet is assumed to be in the well known default class (class-default).

Traffic Conditioning

A traffic stream is selected by a classifier, which steers the packets to a logical instance of a traffic conditioner (marker, meter/policer).

Marking

Packet marking is a traffic conditioning action, performed on an identified flow at the ingress port. The marking action could cause the DSCP / precedence bits to be re-written or left unchanged, depending on user configuration.

The following types of markers are supported:

DSCP markers:

- Packet markers set the DS field of a packet to a particular code point, adding the marked packet to a particular DS behavior aggregate. Based on configurations, each packet matching a particular classifier may be marked with the specified DSCP value.The marker has the capability of marking all the 64 possible DSCP values.

IP-Precedence markers:

- To maintain compatibility with the 3 bit IP precedence (Class of Service) contained in the TOS byte of the IP header, the marker provides an option to mark a classified packet with a specified IP precedence value. The marker has the capability of marking all the 8 possible IP-precedence values. The remaining 3 bits of the DSCP field are set to zero.

Trusted Traffic:

- This is a class of traffic that has a service level agreement with an upstream router, and, as a result, may not require the application of a marker.

Note If a marking action is not configured, that class of traffic is implicitly trusted. Alternatively, the user may specifically configure the class of traffic as trusted.

Metering and Policing

Traffic matching a classifier may be metered using the Token Bucket Algorithm. The result of this metering is used to decide whether to police a particular traffic stream or not.

Incoming packets are passed unaltered if the packet conforms to the traffic profile for that class. Out of profile packets are discarded or marked down, depending on user configuration.

There are 32 instances of meters/policers available per physical interface. These may be distributed between Multi-Field/Behavior Aggregate classifiers as required by the user.

Note There must be at least one traffic conditioning element associated with every classifier in an input policy map.

Per Hop Behavior Definition

Per Hop Behavior or PHB is the externally observable forwarding behavior (in terms of buffer/bandwidth resource allocation), applied to a particular traffic class. This is essentially defined by the queuing/scheduling/buffer management in the forwarding path.

Queuing

Once the traffic stream is classified and conditioned, the forwarding engine is consulted to get the destination interface to which the packet needs to be switched. There are four output queues for each physical interface and each can be assigned to an output traffic class. A direct lookup table, called the queue selector table, is used to determine which is the correct queue for the packet. This table is indexed using a combination of the output interface and DSCP from the packet header.

All entries in this table are initialized to 0 by default (Q0 is the queue for best effort behavior). This mapping may be changed through user configuration.

Figure 22-2 Four Queues Per Physical Interface

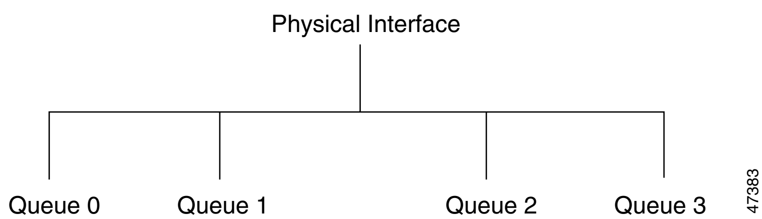
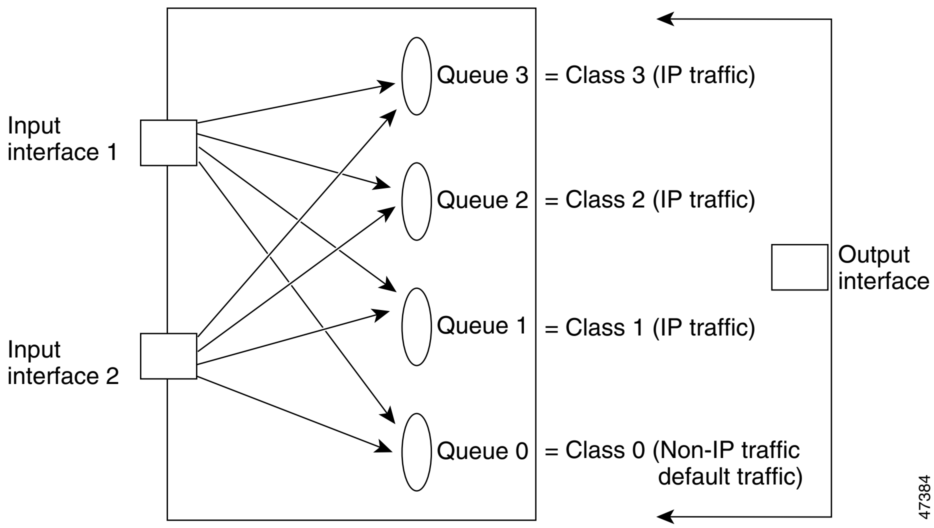


Figure 22-3 shows queue-implementation for each physical interface. Each queue can be assigned to a particular output traffic class.

Figure 22-3 Queue Implementation



Buffer Management

Each queue is associated with a threshold buffer group, which essentially defines a set of parameters for buffer management and drop behavior.

Threshold group parameters are defined as follows:

Discard limit value:

- This is the maximum queue length (in bytes), beyond which the packet will be tail-dropped.

Marking limit value:

- This is the point in the queue (in bytes), after which packets in the queue will have the EFCI bit set.

Note The threshold group parameters are configured in bytes and are rounded up so as to be multiples of an ATM cell payload (48 bytes).

The Catalyst 8540 has a maximum of four buffer groups, and the above parameters may be defined for each of these buffer groups through user configuration.

Scheduling

Each of the four traffic classes are served by the scheduler according to it's configured weight. Scheduling is done using the Weighted Round Robin Algorithm.

The WRR scheduler guarantees a minimum bandwidth to each class, based on the assigned weight. Idle bandwidth is shared among the classes in a fair manner.

Congestion Control

Two drop policies are supported, tail drop and XPIF based Random Early Detect (or xRed).

Tail Drop

Queues fill up during periods of congestion. When the output queue is full and tail drop is in effect, packets are dropped until the congestion is eliminated and the queue is no longer full.

On the Catalyst 8540, the point at which packets will start getting dropped is the user configured discard limit - as soon as the buffer filling drops below this threshold, packets will no longer be dropped) This is the default congestion avoidance mechanism.

xRED

This is a variation of the Random Early Detection Algorithm, as implemented on the Catalyst 8540.

A packet is EFCI-marked if the length of the queue in which it is buffered exceeds a pre-set marking threshold. By counting the number of EFCI-marked packets over an interval at an output port, the degree of congestion of the output port can be assessed.

In a given time interval, if Ne represents the total number of EFCI marked packets and Nt represents the total number of packets, then the ratio Ne/Nt follows the average queue length.

Thus, the port's average queue length is monitored, and packets are randomly discarded with a variable probability if the average queue length exceeds the configured threshold.

Configuring IP QoS Policies Using the Modular CLI

This section describes the tasks for configuring IP QoS functionality with the Modular QoS CLI.

For a complete description of the commands mentioned in this section, refer to the *Cisco IOS Quality of Service Solutions Command Reference*. The commands are listed alphabetically within the guide. To locate documentation of a specific command, use the command reference, master index, or on-line search.

Note The Catalyst 8500 does not support all the commands documented in the *Quality of Service Solutions Command Referenc*e.

IP QoS—Functional Differences Between Modules (Catalyst 8540 MSR)

This section lists the basic differences in IP QoS functionality for the enhanced Gigabit Ethernet (XPIF based) interface module and the enhanced ATM Router Module. It also provides an introduction to differentiated services for ATM forum VCs and describes their configuration commands.

Note The IP QoS feature is only applicable for enhanced Gigabit Ethernet and enhanced ATM Router Modules installed in the Catalyst 8540 MSR chassis.

Input Policy

All functionality, such as classification, marking, metering, and policing, is the same for both the enhanced Gigabit Ethernet (XPIF based) interface module and the enhanced ATM Router Module.

The difference is that all incoming traffic to the enhanced Gigabit Ethernet (XPIF based) interface module received on the cable is treated as ingress traffic that is eligible for input policy functions.

On the enhanced ATM Router Module, there is no physical connectivity, so traffic that comes in from an ATM interface to the enhanced ATM Router Module is eligible for input policy functions. This traffic stream can egress an Ethernet interface, or an enhanced ATM Router Module interface (and egress through an ATM interface). However, the traffic stream coming from an Ethernet interface and egressing an ATM interface is not eligible for input policy functions on the enhanced ATM Router Module.

Output Policy

The functionality for queue selector and congestion management is the same for both the enhanced Gigabit Ethernet (XPIF based) interface module and the enhanced ATM Router Module.

The difference is bandwidth allocation. On the enhanced ATM Router Module, bandwidth allocation is calculated using the following scheduler class weight formula:

WRR(A) = 255 * (Bandwidth of A) /[(Total Bandwidth for IPQoS config) + 500,000 K]

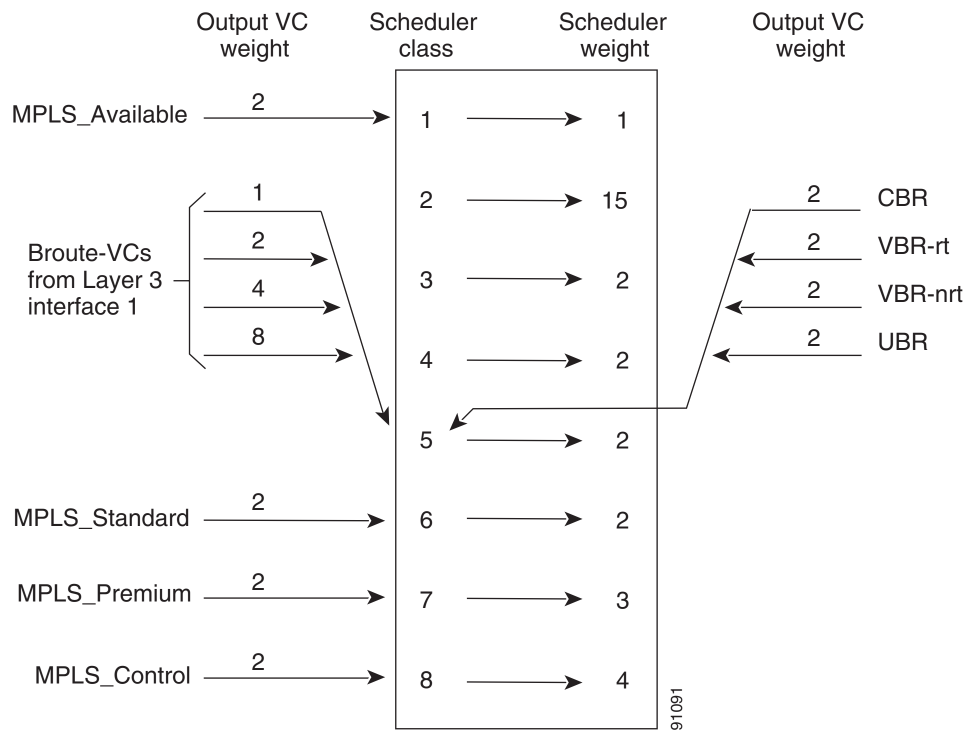
This formula is used because the enhanced ATM Router Module handles traffic from both Ethernet and ATM interfaces, where 500,000 KB of bandwidth is always reserved for ATM traffic. This bandwidth is only used for scheduler class weight calculation. The unused bandwidth can be used by ATM or Ethernet traffic because of the weighted round-robin (WRR) scheduler.

Differentiated Services for ATM Forum VCs

The differentiated services for ATM forum VCs enables the enhanced ATM Router Module to treat ATM traffic with better granularity, providing minimum assurance for a particular traffic class when the enhanced ATM Router Module is operating at congestion level and beyond.

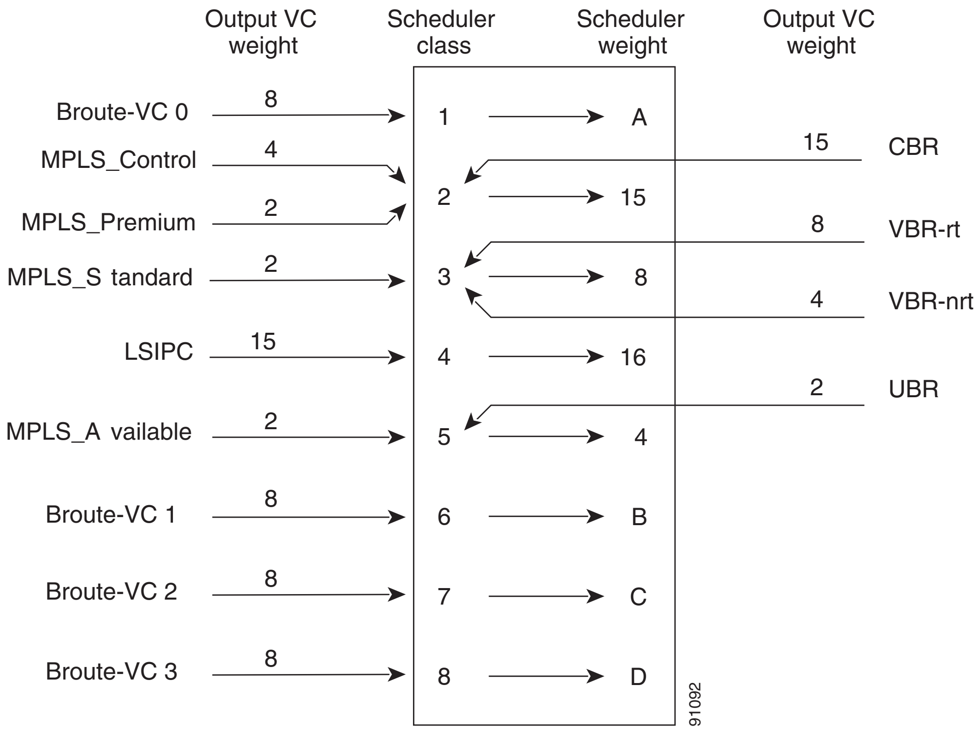
Since rate scheduler is not available on the enhanced ATM Router Module, in the earlier implementation, eight scheduler classes of one WRR scheduler were used, as shown in Figure 22-4.

Figure 22-4 Previous Scheduler Class Weight Diagram



It is now possible to control bandwidth for a traffic class using scheduler class bandwidth and output VC weight, as shown in Figure 22-5.

Figure 22-5 Current Scheduler Class Weight Diagram



In Figure 22-5, the Broute-VCs move to scheduler classes 1, 6, 7 and 8 only if the IP QoS feature is configured on the interface. If IP QoS is not configured on the interfaces all Broute-VCs map to scheduler class 5, as show in Figure 22-4.

In Figure 22-5, the characters A, B, C and D, shown under Scheduler weights, are associated with scheduler classes 1, 6, 7 and 8. These weights are calculated based on the bandwidth you configure using the IP QoS policy feature.'

For example, in Figure 22-5, to control bandwidth for a traffic class using scheduler class bandwidth and output VC weight with a high scheduler weight for class 2, the enhanced ATM Router Module regards CBR traffic as more critical than any other traffic class. Plus, output VC weight can be used to differentiate between VCs of the same class. Configuring output VC weight might be necessary because of different PCR and SCR values for the same class of VCs.

Note Scheduler class weight for 2, 3, and 5 are enabled by default in Cisco IOS Release 12.1(14)EB. No configuration is required.

To configure the scheduler class weight, use the following commands:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm service-class** {**2** | **3** | **5**} **wrr-weight** *1-15*	Enters the scheduler class and weight for a physical interface.

Example

The following example shows how to configure service class 2 and WRR weight 2:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm service-class 2 wrr-weight 2
```

To configure the output VC, use the following commands:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm pvc** *vpi-A vci-A* **wrr-weight** *1-15* **interface atm** *card/subcard/port vpi-B vci-B* **wrr-weight** *1-15*	Configures the WRR weight to output VC of the output leg of the PVC.

Example

The following example shows how to configure the WRR weight to the output VC of the output leg of the PVC:

```
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm pvc 2 1000 wrr-weight 2 interface atm 1/0/0 2 1000 wrr-weight 2
```

Displaying the IP QoS Configuration

To display the IP QoS configuration, use the following commands:

Command	Purpose
Switch# **show epc ip-atm-qos interface atm** *card/subcard/port*	Displays bandwidth and weights of the scheduler classes.
Switch# **show atm interface resource atm** *card/subcard/port*	Displays the amount of bandwidth allocated for IP QoS.

Example

The following example uses the **show epc ip-atm-qos interface** command to show the bandwidth and weights of the scheduler classes:

```
Switch# show epc ip-atm-qos interface atm 11/0/1
MMC Port: 119       MSC ID: 7       Port num in MSC:0

Service  Application                  WRR Weight       Bandwidth(Kbps)
 Class                            External  Internal Configured  Actual
-----------------------------------------------------------------------
1     default                          *    51      200000      91234
6     b                                *    51      200000      91234
7     a                                *    25      100000      44722
2     CBR                             15    240     198000      429338
3     VBR-RT/VBR-NRT                   8    128     151499      228980
4     LSIPCs                          15    255
5     UBR/UBR+                         4    64      0           114490
-------------------------------------------------------------------
 * - External Weights for IPQoS is assigned through Bandwidth CLI
```

```
Switch#
```

The following example uses the **show atm interface resource** command to show the amount of bandwidth allocated for IP QoS:

```
Switch# show atm interface resource atm 11/0/1
Resource Management configuration:
    CAC Configuration to account for Framing Overhead : Disabled
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    overbooking :  disabled
    Per Class OverBooking :
            vbr-rt : disabled,     vbr-nrt : disabled
            abr : disabled,        ubr : disabled
    Service Categories supported: cbr,vbr-rt,vbr-nrt,ubr
    Link Distance: 0 kilometers
    Controlled Link sharing:
        Max aggregate guaranteed services: none RX,  none TX
        Max bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none ubr RX, none ubr TX
        Min bandwidth: none cbr RX, none cbr TX, none vbr RX, none vbr TX,
                       none ubr RX, none ubr TX
    Best effort connection limit: disabled  0 max connections
    Max traffic parameters by service (rate in Kbps, tolerance in cell-times):
        Peak-cell-rate RX: none cbr, none vbr, none ubr
        Peak-cell-rate TX: none cbr, none vbr, none ubr
        Sustained-cell-rate: none vbr RX, none vbr TX
        Minimum-cell-rate RX: none ubr
        Minimum-cell-rate TX: none ubr
        CDVT RX: none cbr, none vbr, none ubr
        CDVT TX: none cbr, none vbr, none ubr
        MBS: none vbr RX, none vbr TX
Resource Management state:
    Bandwidth Allocated to IPQoS       (in Kbps): 500000
    Total Available Interface Bandwidth (in Kbps): 251999
    Available bit rates (in Kbps):
        251999 cbr RX, 251999 cbr TX, 251999 vbr RX, 251999 vbr TX,
        0 abr RX, 0 abr TX, 251999 ubr RX, 251999 ubr TX
    Allocated bit rates:
        198000 cbr RX, 198000 cbr TX, 0 vbr RX, 0 vbr TX,
        0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
    Best effort connections: 136 pvcs,  0 svcs
Switch#
```

Supported and Unsupported Features

The following features are supported:

- Enhanced ATM Router Module supports classification based on Behavior Aggregate and Multifield classifiers, marking, metering, and policing.
- XRED is supported for congestion control.
- Weighted fair queuing is the only queuing algorithm supported.
- Maximum of 4 output queues.
- Maximum of 16 classes in input policy map.
- Maximum of 64 subinterfaces with input policy.
- Maximum of 32 policers per physical interface.

The following features are *not* supported:

- Multifield classifiers in output policy

  Workaround: none
- Hierarchical policy maps

  Workaround: none
- Strict priority and low latency queueing (LLQ)

  Workaround: Though strict priority and LLQ cannot be completely substituted with WFQ, high bandwidth can be assigned to critical traffic to ensure that it gets a higher scheduling weight and is the least likely to be dropped in case of congestion. But, in the absence of policing for this class, the high bandwidth you assign for critical traffic can easily hog the bandwidth if excessive traffic is sent on this class.
- Link fragmentation and interleaving (LFI) for Frame Relay

  Workaround: none
- Egress marking

  Workaround: none
- Limitation on guaranteed IP QOS bandwidth

  The switching capacity of the enhanced ATM Router Module is 1 Gbps. So logically, you can configure an output policy map where the sum of bandwidths of all classes can reach 1 Gbps. However, Ethernet traffic is not the only traffic serviced by the enhanced ATM Router Module. ATM traffic, which must be routed, is also serviced by the enhanced ATM Router Module. Hence, it is not possible to reserve the entire 1 Gbps of bandwidth for Ethernet. Even if you configure a policy for 1 Gbps, only 500 Mbps are guaranteed, taking into account 500 Mbps for ATM. Only if there is no ATM traffic is the entire 1 Gbps available for Ethernet, and vice versa.
- QoS for IP multicast

  Workaround: none
- IP multicast on VC bundle

  Workaround: none

Configuring IP QoS on Enhanced Gigabit Ethernet and Enhanced ATM Router Module Interfaces

The IP QoS configuration requires the following three steps, which are detailed in this section:

Step 1 Defining a traffic class with a **class-map** command

Step 2 Creating a service policy by associating the traffic class with one or more QoS policies using the **policy-map** command

Step 3 Attaching the service policy to the interface with the **service-policy** command

Defining a traffic class

The **class-map** command is used to define a traffic class.

A traffic class consists of two major elements:

- a name
- one or more match criteria / rules

The following commands describe how to configure a traffic class in global configuration mode:

	Command	Purpose
Step 1	Switch(config) # **class-map** *class-map name*	Specifies the user-defined name of the traffic class.
Step 2	Switch(config-cmap) # **match access-group** *access-group*	Specifies the numbered access list, against whose contents packet headers will be checked to determine if they belong to the class. (Multifield classification)
	Switch(config-cmap) # **match access-group name** *access-group*	Specifies the named access list, against whose contents packet headers will be checked to determine if they belong to the class. (Multifield classification)
	Switch(config-cmap) # **match ip precedence** *number*	Specifies up to eight IP precedence values separated by spaces, to be used as match criteria. (Behavior Aggregate classification).
	Switch(config-cmap) # **match ip dscp** *number*	Specifies up to eight differentiated services code point (DSCP) values, separated by spaces, to be used as match criteria. The value of each service code point is between 0 and 63. (Behavior Aggregate classification).

Example

The following example shows how to configure a multi-field classifier:

```
Switch(config)# class-map eng-traffic
Switch(config-cmap)# match access-group 101
Switch(config-cmap)# match access-group name tac-traffic
The following example shows how to configure a BA classifier:
Switch(config)# class-map critical-traffic
Switch(config-cmap)# match ip precedence 7
Switch(config)# class-map other-traffic
Switch(config-cmap)# match ip dscp 1 2 3 4 5 6 7 8

Switch(config-cmap)# match ip dscp 9 10 11
Switch(config)# class-map mixed-traffic
Switch(config-cmap)# match ip dscp af11
Switch(config-cmap)# match ip precedence 1
```

Note Multiple match commands may be specified within the same class-map.

Multifield (MF) classifiers may only be used within input policy maps while Behavior Aggregate classifiers may be used within input and/or output policy maps.

Creating a Service Policy

The **policy-map** command is used to define a service policy.

A policy map definition consists of:

- a name

- a set of classifiers (class-maps)
- their associated traffic conditioners (for input policy maps) or per hop behavior (PHB) definitions (for output policy maps).

The following commands show how to configure a service policy on an ingress interface (input policy map):

	Command	Purpose
Step 1	Switch(config) # **policy-map** *policy-name*	Specifies the name of the service policy to configure.
Step 2	Switch(config-pmap) # **class** *class-name*	Specifies the name of a predefined class, which was defined with the **class-map** command
	Switch(config-pmap-c) # **class class-default**	Specifies the well known default class.
Step 3	Switch(config-pmap-c) # **police** *rate burst* **exceed-action** [**drop** | **set-dscp-transmit** *dscp-value* | **set-precedence-transmit** *ip precedence-value*]	Specifies three parameters to define the meter and policer rate is the average rate of data arrival (in Kbits/sec) burst is the maximum burst (in bytes) exceed action is either drop or mark down.
	Switch(config-pmap-c) # **set ip-precedence** *ip-precedence-value*	Specifies an IP precedence marker. The IP precedence value can be any value between 0 and 7.
	Switch(config-pmap-c) # **set ip dscp** *ip-dscp-value*	Specifies a DSCP marker. The DSCP value can be any value between 0 and 63.
	Switch(config-pmap-c) # **set ip** [**precedence** | **dscp**] **unchanged**	Specifies trusted traffic.

Example

```
Switch(config)# policy-map in-policy
Switch(config-pmap)# class one
Switch(config-pmap-c)# set ip dscp 48
Switch(config-pmap-c)# police 96000000 16000000 exceed-action set-dscp-transmit 0
Switch(config-pmap)# class two
Switch(config-pmap-c)# set ip precedence unchanged
Switch(config-pmap-c)# police 96000000 16000000 exceed-action set-dscp-transmit 0
Switch(config-pmap-c)# class-default
Switch(config-pmap-c)# set ip dscp 0
```

Note Input policy maps:

- can have a maximum of 16 class maps including the default class.
- may be configured on the physical interface or on any 64 subinterfaces on the physical interface.
- have a maximum number of 32 policer instances which can be applied per physical interface.
- should have sufficient TCAM space available for the policy to be programmed (minimum 512 entries).

The following commands show how to configure a service policy on an egress interface (output policy map):

	Command	Purpose
Step 1	Switch(config) # **policy-map** *policy-name*	Specifies the name of the service policy to configure.
Step 2	Switch(config-pmap) # **class** *class-name*	Specifies the name of a predefined class, which was defined with the **class-map** command
	Switch(config-pmap-c) # **class class-default**	Specifies the default class
Step 3	Switch(config-pmap-c) # **bandwidth** *kbps*	Specifies a minimum bandwidth (in Kbits/sec) guaranteed to a traffic class. This must be specified for each class in the output policy, including class-default.
	Switch(config-pmap-c) # **random-detect** [**buffer-group** *buffer-group-number* | **max-probability** *max-probability* | **freeze-time** *millisecond*]	Enables the XPIF based Random Early Detect (xRED) drop policy. *buffer-group-number* specifies one of 4 possible buffer groups available (value 0 to 3) *max-probability* range is 1 to 65535, and *freeze-time* range is 10 to 2000 milliseconds.
	Switch(config-pmap-c) # **queue-limit buffer-group** *buffer-group-number*	Configures the Tail drop policy. *buffer-group-number* specifies one of 4 possible buffer groups available (value 0 to 3)

Example

```
Switch(config)# policy-map out-policy
Switch(config-pmap)# class prec2
Switch(config-pmap-c)# bandwidth 10000
Switch(config-pmap-c)# class prec4
Switch(config-pmap-c)# bandwidth 100000
Switch(config-pmap-c)# random-detect buffer-group 2 max-probability 1024 freeze-time 100
Switch(config-pmap-c)# class prec6
Switch(config-pmap-c)# bandwidth 100000
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# bandwidth 10000
```

Note Output policy maps:

- Can have a maximum of 4 class maps, including the default class.
- May be configured only on the physical interface.
- The classifiers on the output direction must be Behavior Aggregate classifiers.
- Must have exactly one class with ‘match any’ for default/unclassified traffic.
- Must have bandwidth configured for every class.
- ‘queue-limit’ or ‘random-detect’ are mutually exclusive. ‘queue-limit’ is the default if nothing is configured.

Configuring Buffer-Groups

Buffer groups are global resources that can be configured to be shared among output traffic classes. Four possible buffer groups are available.

Command	Purpose
buffer-group *buffer-group-number* **discard-limit** *discard-limit-range* **mark-limit** *mark-limit-range*	Specifies the threshold buffer group parameters *buffer-group-number* is an integer identifying the group (range 0-3) *discard-limit range* is the maximum queue length in bytes, beyond which the packet will be tail-dropped *mark-limit range* is the point in the queue (in bytes), after which packets in the queue will have the EFCI bit set.

Note Configuring the discard-limit and the mark-limit using the **buffer-group** command is optional and not a necessary step in defining a service policy. If the buffer-group is not configured, default values for discard-limit and mark-limit apply.

Attaching a Service Policy to an Interface

Use the **service-policy** interface configuration command to attach a service policy to an interface and to specify the direction of the policy application (either on packets coming into the interface or packets leaving the interface).

Use the **no** form of the command to detach a service policy from an interface. The **service-policy** command syntax is:

service-policy {**input** | **outpu**t} *policy-map-name*

no service-policy {**input** | **outpu**t} *policy-map-name*

Command	Purpose
Switch(config-if) # **service-policy output** *policy-map-name*	Attaches the output service policy to the interface
Switch(config-if) # **service-policy input** *policy-map-name*	Attaches the input service policy to the interface

Although you can assign the same service policy to multiple interfaces, each interface can have only one service policy attached at the input and only one service policy attached at the output.

Example

```
Switch(config)# interface gigabitethernet 1/0/1
Switch(config-if)# service-policy output out-policy

Switch(config-if)# interface gigabitethernet 0/0/1.15
```

```
Switch(config-if)# service-policy input in-policy
```

TCAM Region for IP QoS

By default, there is no space reserved for IP QoS in TCAM. There needs to be a minimum of 512 entries for the IP QoS region in TCAM, for IP QoS functionality to be enabled.

This size is configurable, but requires a reload to take effect If enough space is not available in TCAM after the reload, IP QoS will get disabled automatically.

Tips TCAM space may be allocated for IP QoS using the command:

sdm ipqos *number_of_entries*.

Verifying the IP QoS Configuration

To verify the IP QoS configuration, use the following commands:

Command	Purpose
Switch # **show class-map**	Displays all the traffic class information.
Switch # **show class-map** *class-name*	Displays the traffic class information for the user-specified traffic class.
Switch # **show policy-map**	Displays all configured service policies.
Switch # **show policy-map** *policy-map-name*	Displays the user-specified service policy.
Switch # **show policy-map** *interface*	Displays configurations of all input and output policies that are attached to an interface.
Switch # **show policy-map interface** *interface-spec* **input**	Displays configuration of the input policy attached to the interface.
Switch # **show policy-map interface** *interface-spec* **output**	Displays configuration of the output policy attached to the interface.
Switch # **show policy-map interface** [interface [*interface-spec* [**input** | **output**] [**class** class-name]]]	Displays the configuration of the class name configured in the policy.
Switch # **show sdm size** [**current** | **configured**]	Displays the currently allocated or the configured TCAM region sizes for different features

Examples

The following example shows all policy maps configured:

```
Switch# show policy-map
 Policy Map four
  class  five
   set ip dscp unchanged
  class  six
   set ip precedence 7
```

```
 Policy Map one
  class  one
   set ip dscp unchanged
  class  two
   set ip dscp 63
  class  three
   set ip precedence 0
  class  four
   set ip precedence 7
  class  five
   set ip dscp 22
  class  six
   set ip precedence unchanged
  class  seven
   set ip dscp 13
  class  eight
   set ip dscp 31
  class  nine
   set ip dscp unchanged
  class  ten
   set ip precedence 3

 Policy Map two
  class  five
   police 32000 1000 exceed-action drop
  class  four
   police 33000 2000 exceed-action set-dscp-transmit 0
  class  three
   police 32000 3300 exceed-action set-prec-transmit 0
  class  two
   police 44000 1980 exceed-action drop

 Policy Map three
  class  one
   set ip dscp 1
  class  four
   set ip dscp 4
  class  three
   set ip precedence 1
```

The following example shows a particular policy map configuration:

```
Switch# show policy-map one

 Policy Map one
  class  one
   set ip dscp unchanged
  class  two
   set ip dscp 63
  class  three
   set ip precedence 0
  class  four
   set ip precedence 7
  class  five
   set ip dscp 22
  class  six
   set ip precedence unchanged
  class  seven
   set ip dscp 13
  class  eight
   set ip dscp 31
  class  nine
   set ip dscp unchanged
```

```
 class  ten
  set ip precedence 3
```

The following example shows all class maps configured:

```
Switch# show class-map
 Class Map match-all nine (id 10)
   Match access-group  33

 Class Map match-all four (id 5)
   Match access-group  1
   Match access-group  2
   Match access-group  4
   Match access-group  6
   Match access-group  8
   Match access-group  12
   Match access-group  16
   Match access-group  25
   Match access-group  31
   Match access-group  21
   Match access-group  13

 Class Map match-all five (id 6)
   Match ip dscp 5 13 22 27 34 44 45 63

 Class Map match-any class-default (id 0)
   Match any
 Class Map match-all six (id 7)
   Match ip dscp 2
   Match ip dscp 3 4 5 6 7 8 9
   Match ip dscp 52 53

 Class Map match-all one (id 2)
   Match access-group name cache-in

 Class Map match-all seven (id 8)
   Match ip precedence 2

 Class Map match-all two (id 3)
   Match access-group  102

 Class Map match-all three (id 4)
   Match access-group  142
   Match access-group  169

 Class Map match-all eight (id 9)
   Match access-group name std-stuff

 Class Map match-all ten (id 11)
   Match access-group  102
   Match access-group  112
```

CHAPTER 23

Configuring the ATM Traffic-Shaping Carrier Module

This chapter describes the features and configuration procedures for the ATM traffic-shaping carrier module (TSCAM). The TSCAM is available on the Catalyst 8510 MSR and the LightStream 1010 ATM switch routers.

Note This chapter provides advanced configuration instructions for the Catalyst 8510 MSR and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM and Layer 3 Switch Router Command Reference* publication.

This chapter includes the following sections:

About the ATM Traffic-Shaping Carrier Module

The ATM traffic-shaping carrier module (TSCAM) augments the current traffic-shaping capabilities for the Catalyst 8510 MSR and the LightStream 1010 ATM switch routers by providing variable bit rate (VBR) and best-effort traffic-shaping capabilities. The TSCAM shapes the streams of cells sent over virtual connections (VCs) so they conform to bandwidth parameters, and they do not exceed the expected flow into the network. The TSCAM does this by temporarily holding cells in buffers and dispersing them as bandwidth parameters allow on the outgoing connection. The TSCAM helps ensure that cells are not dropped if they exceed the maximum traffic-flow parameters established between private and public networks.

You can enable traffic shaping on subcard 0 of a slot that is equipped with the TSCAM. For OC-3, T1, E1, and DS3 port adapters, a maximum of four traffic classes can be shaped. For example, if only VBR traffic is shaped, traffic shaping for VBR can be configured on a maximum of four ports (each port shapes two classes). If VBR traffic and best-effort traffic is shaped, a maximum of two ports can be configured for traffic shaping. For OC-12 port adapters, only one traffic class can be shaped.

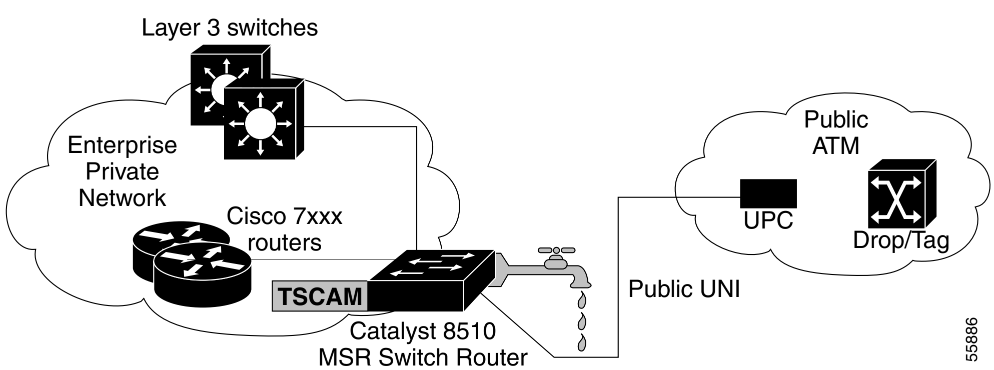
Note Traffic-shaping configurations do not apply to regular virtual path (VP) tunnels defined on that interface, except in the case of unspecified bit rate (UBR) VP tunnels. For example, when best-effort traffic shaping is enabled on a physical interface, all the UBR VP tunnels defined on that interface are shaped to their peak cell rate (PCR), but individual VCs within those VP tunnels are not shaped.

The TSCAM schedules the traffic classes constant bit rate (CBR), VBR, and best effort in a strict priority in which CBR is the highest priority and best effort is the lowest priority. The best-effort traffic class includes UBR, available bit rate (ABR) and UBR+ service categories. When traffic shaping is disabled for all the traffic classes on a port, all the traffic from that port is switched unaltered as if it were a single connection at the highest priority.

Note Traffic shaping in the TSCAM is disabled by default. Any changes to shaping configurations are supported across switch reloads only.

An example of how the ATM TSCAM might work in a network is shown in Figure 23-1. In this example, the TSCAM is in a Catalyst 8510 MSR switch router that is on the edge of a private enterprise network connected to a public ATM network. The TSCAM helps ensure that the maximum number of cells transmit through to the public network.

Figure 23-1 TSCAM on an Enterprise Private Network



ATM TSCAM Features

The ATM TSCAM offers the following benefits:

- Traffic shaping for up to four ports on any combination of T1, E1, and DS3 ports
- Traffic shaping for up to three ports on OC-3 ports
- Traffic shaping for up to one OC-12 port
- VC functionality for up to 32K VCs
- An aggregate bandwidth of OC-12
- Online insertion and removal (OIR)

- Traffic shaping for VBR and best-effort traffic
- Up to four TSCAMs in a chassis
- Up to four ports 256K cell buffers share

Hardware and Software Restrictions

This section lists the hardware and software restrictions for the TSCAM.

Hardware Restrictions

The following hardware restrictions apply to the TSCAMs of the Catalyst 8510 MSR and LightStream 1010 ATM switch:

- Although the TSCAM occupies one full slot on the switch router, the traffic-shaping functionality can only be applied to ports on subcard 0.
- The TSCAM accommodates only OC-3, T1, E1, DS3, or OC-12 port adapters.
- Only three traffic classes can be shaped on the OC-3 port adapter.
- The TSCAM is not compatible with the FC-PCQ feature card.
- Successive OIR operations must have a delay of 1 minute between them, especially reseating a TSCAM itself or reseating the port adapter in subslot 0 in the TSCAM.

Software Restrictions

The following software restrictions apply to the TSCAMs of the Catalyst 8510 MSR and LightStream 1010 switch routers:

- Each TSCAM requires 2 MB of continuous main memory availability in the switch.
- Well-known VCs on an interface that is enabled for VBR traffic shaping will be automatically shaped at the maximum cell rate of that interface. Changing shaping properties for these VCs is not allowed.
- Any changes to the shaping configurations are supported across switch reloads.
- Tag switching VCs and Multiprotocol Label Switching (MPLS) VCs are not currently supported.
- The maximum rate to which a VC can be shaped on an OC-12 interface is 595,085 Kbps
- The minimum rate that a VC can be shaped is as follows:
  - 36 Kbps for DS3, E3, T1, E1, and OC-3 interfaces
  - 145 Kbps for OC-12 interfaces
- When VBR connections are shaped using sustainable cell rate (SCR), PCR, and maximum burst size (MBS), the burst tolerance computed always rounds up to the next higher value that conforms to the expression ((2^n)-1). For example, if the burst tolerance calculated is 144, the actual burst tolerance used is 255 or ((2^8)-1).

Note Burst tolerance is not applicable to the shaping of best-effort connections and the PCR-only mode of shaping for VBR connections.

- Each TSCAM requires 2 MB of contiguous main memory availability in the system.
- The maximum rate at which a VC can be shaped on an OC-12 interface is 595,085 Kbps.
- The minimum rate at which a VC can be shaped to is as below :
  - 36 Kbps for DS3, E3, T1, and E1 interfaces
  - 37 Kbps for OC-3 Interfaces
  - 145 Kbps for OC-12 Interfaces.

About Interface Congestion Thresholds

A total of 256K cell buffers are available on the TSCAM. On an interface enabled for shaping, the number of available cell buffers is the same as the maximum threshold for that interface. Table 23-1 lists the maximum threshold values. These values are the defaults and depend on the number of interfaces configured for traffic shaping. The maximum congestion thresholds for interfaces are not configurable.

Table 23-1 Default Interface Maximum Thresholds

Number of Shaped Interfaces	Maximum Cell Threshold for Unshaped Interfaces	Maximum Cell Threshold for Shaped Interfaces
0	65536	0
1	2816	253952
2	4096	126976
3	4096	86016
4	0	65536

Configuring the ATM TSCAM

To configure traffic shaping on your ATM TSCAM, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Selects the physical interface to be configured.
Step 2	Switch(config-if)# **atm traffic shaping enable** {**vbr** [**pcr-only**] | **best-effort**} Switch(config-if)# **exit**	Enables traffic shaping.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Copies the running configuration in system memory to the startup configuration stored in NVRAM.

Note Any changes to the traffic-shaping configuration take effect upon saving the configurations to NVRAM and reloading the switch, or upon performing an OIR on the port adapter in subcard 0 of the ATM TSCAM.

Example

The following example shows how to enable VBR traffic shaping:

```
Switch# configure terminal
Switch(config)# interface atm 4/0/0
Switch(config-if)# atm traffic shaping enable vbr
Switch(config-if)# end
Switch# copy system:running-config nvram:startup-config
```

Configuring Maximum Thresholds

The ATM TSCAM supports maximum thresholds for traffic class and for VCs. This section describes how to configure these thresholds.

Configuring Maximum Thresholds for Traffic Classes

To configure traffic class thresholds, perform the following steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	Switch# **show atm vc atm** *slot/subslot/port*	Verifies that the VCs on the interface are in a down state.
Step 2	Switch# **configure terminal** Switch(config)#	Enters interface global configuration mode.
Step 3	Switch(config)# **interface atm** *slot/subslot/port* Switch(config-if)#	Enters interface configuration mode.
Step 4	Switch(config-if)# **shutdown**	Disables the interface.
Step 5	Switch(config-if)# **atm traffic shaping thresholds class {best-effort | vbr} maximum** *percent*	Sets traffic-shaping thresholds on an interface.
Step 6	Switch(config-if)# **no shutdown**	Enables the interface.

Note Prior to changing the traffic class maximum threshold configuration, you must disable the interface using the **shutdown** command. You do not have to disable the interface when configuring per-VC maximum thresholds.

Example

The following example shows how to configure a traffic-shaping threshold for a traffic class:

```
Switch# show atm vc interface atm 0/0/0
Interface         VPI  VCI    Type   X-Interface       X-VPI X-VCI Encap  Status
ATM0/0/0          0    5      PVC    ATM0              0     49    QSAAL  DOWN
ATM0/0/0          0    16     PVC    ATM0              0     35    ILMI   DOWN
Switch# configure terminal
Switch(config)# interface atm 0/0/0
Switch(config-if)# shutdown
Switch(config-if)# atm traffic shaping thresholds class vbr maximum 80
Switch(config-if)# no shutdown
```

Note Class maximum thresholds are expressed as percentages of the interface maximum threshold values. To display interface maximum thresholds, enter the **show atm interface resource atm** *slot/subslot/port* in privileged EXEC mode.

Configuring Maximum Thresholds for VCs

To configure VC thresholds, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *slot/subslot/port* Switch(config-if)#	Enters interface configuration mode.
Step 2	Switch(config-if)# **atm traffic shaping thresholds vc {best-effort | vbr} maximum** *buffers*	Sets traffic-shaping thresholds on an interface.

Note New per-VC maximum thresholds only apply to new VCs created after making the threshold configuration changes. The new threshold configuration is not applied to the maximum threshold values of existing VCs.

Example

The following example shows how to configure traffic-shaping thresholds for VCs:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm traffic shaping thresholds vc vbr maximum 3000
```

Displaying Traffic-Shaping Configurations

To show the traffic-shaping configuration of the switch, use the following privileged EXEC commands:

Command	Purpose
Switch# **show atm traffic shaping slot** *slot*	Verifies that traffic shaping is enabled on a slot.
Switch# **show atm interface resource atm** *slot/subslot/port*	Verifies the traffic-shaping threshold configurations.
Switch# **show atm vc interface atm** *slot/subslot/port vpi vci*	Displays traffic-shaping statistics.

Examples

The following example shows the configured ports on a Catalyst 8510 MSR switch router:

```
Switch# show atm traffic shaping slot 4
CATS Carrier Module State : ACTIVE
Shaper Configuration Status :
   Shapers In Use by Config : 3  Shapers Available for Config : 1
Shaper Hardware Status :
   Shaper 0 :  In Use - interface : atm 4/0/1 - Class : vbr
   Shaper 1 :  In Use - interface : atm 4/0/2 - Class : Best-Effort
   Shaper 2 :  Not In Use.
   Shaper 3 :  Not In Use.
Statistics :
   Total cell discards = 15, clp0 discards = 3,  clp1 discards = 12
   Free cell buffers = 203852
   cells queued for all ports = 58291
```

The following example shows the threshold values configured on a Catalyst 8510 MSR switch router:

```
Switch# show atm interface resource atm4/0/0
Resource Management configuration:
    Service Classes:
        Service Category map: c2 cbr, c2 vbr-rt, c3 vbr-nrt, c4 abr, c5 ubr
        Scheduling: RS c1 WRR c2, WRR c3, WRR c4, WRR c5
        WRR Weight: 15 c2, 2 c3, 2 c4, 2 c5
    Interface traffic-shaping Configuration:
        VBR Shaping : Enabled in Config - Enabled In hardware
        Best-Effort Shaping : Enabled in Config - Enabled In hardware
    VBR Class MaxThreshold :
     Configuration : 40%, Installed Cell Buffers : 47104
    Best-Effort Class MaxThreshold :
     Configuration : 60%, Installed Cell Buffers : 77824
    Per-VC Queue Thresholds for VBR :
     MaxThreshold : Configured = 512, Installed = 512
    Per-VC Queue Thresholds for Best-Effort :
     MaxThreshold : Configured = 1024, Installed = 1024
CAC Configuration to account for Framing Overhead : Disabled
    Pacing: disabled   0 Kbps rate configured, 0 Kbps rate installed
    overbooking :  disabled
Service Categories supported: cbr,vbr-rt,vbr-nrt,abr,ubr
    Link Distance: 0 kilometers
. . .
. . .
Resource Management state:
Traffic Shaper Interface MaxThreshold (in cell buffers) :
        Currently Installed : 65536,  Value on Next Reset : 65536
Traffic Shaper Interface queue cell count : 0
```

```
Available bit rates (in Kbps):
        147743 cbr RX, 147743 cbr TX, 147743 vbr RX, 147743 vbr TX,
        147743 abr RX, 147743 abr TX, 147743 ubr RX, 147743 ubr TX
    Allocated bit rates:
        0 cbr RX, 0 cbr TX, 0 vbr RX, 0 vbr TX,
        0 abr RX, 0 abr TX, 0 ubr RX, 0 ubr TX
    Best effort connections: 0 pvcs,  0 svcs
```

The following example shows the traffic-shaping statistics on a Catalyst 8510 MSR switch router:

```
switch# show atm vc interface atm 4/0/1 0 5
Interface: ATM4/0/1, Type: oc3suni
VPI = 0  VCI = 5
Status: UP
Time-since-last-status-change: 00:00:25
Connection-type: PVC
Cast-type: point-to-point
Packet-discard-option: enabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 15
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states:  Not-applicable
Cross-connect-interface: ATM0, Type: ATM Swi/Proc
Cross-connect-VPI = 0
Cross-connect-VCI = 84
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state:  Not-applicable
Encapsulation: AALQSAAL
Connection Priority: High
Threshold Group: 6, Cells queued: 0
Rx cells: 7, Tx cells: 5
Tx Clp0:5,  Tx Clp1: 0
Rx Clp0:7,  Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx pkts:7, Rx pkt drops:0
Switch Tx Statistics :
     Tx Clp0 : 5,  Tx Clp1 : 0, TxCells : 5
Rx connection-traffic-table-index: 3
Rx service-category: VBR-RT (Realtime Variable Bit Rate)
Rx pcr-clp01: 424
Rx scr-clp01: 424
Rx mcr-clp01: none
Rx      cdvt: 1024 (from default for interface)
Rx       mbs: 50
Tx connection-traffic-table-index: 3
Tx service-category: VBR-RT (Realtime Variable Bit Rate)
Tx pcr-clp01: 424
Tx scr-clp01: 424
Tx mcr-clp01: none
Tx      cdvt: none
Tx       mbs: 50
Traffic Shaper Connection Identifier : 9
Traffic Shaper Connection Queue Cell Count : 1
AAL5 statistics:
Crc Errors:0, Sar Timeouts:0, OverSizedSDUs:0
BufSzOvfl:  Small:0, Medium:0, Big:0, VeryBig:0, Large:0
```

Traffic-shaping Granularity Tables

This section lists the following granularity tables for configuring traffic-shaping rates on ATM interfaces:

- Table 23-2Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second), page 23-9
- Table 23-3VBR Shaping (Using PCR, SCR and MBS) Values for DS3, E3, E1, and T1 (Cells Per Second), page 23-25
- Table 23-4Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second), page 23-28
- Table 23-5VBR Shaping (Using PCR, SCR and MBS) Rates for OC-3c (Cells Per Second), page 23-43
- Table 23-6Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second), page 23-47
- Table 23-7VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second), page 23-65

The tables display shaping rates in cells per second and can be used for configuring connection traffic table (CTT) rows. When configuring CTT rows, the traffic parameters are specified in kilobits per second (kbps). By referring to the values listed in the tables, you can choose the rate in cells per second that most closely matches the desired kbps rate for CTT rows.

Two granularity tables represent each interface type. For example, Table 23-2 shows rates for best-effort connections and variable bit rate (VBR) connections using PCR-only mode. Table 23-3 shows rates for VBR connections shaped using their PCR, SCR, and MBS parameters (the default VBR shaping mode). The DS3, E3, E1, and T1 interfaces share the same values and are therefore represented in the same granularity tables.

The resource management software uses the following algorithm to convert the rates given in kbps to cells per second. You can also use the algorithm as a guideline for determining the kbps value that must be configured for the CTT rows.

In the following expression, *kbps_val* represents a rate specified in units of kbps and *cps_val* is the cell per second equivalent of the specified *kbps_val*. Also, the following expressions use integer division and the operator % represents modulus operations.

```
intermediate=(kbps_val * 125);
if ((intermediate % 53) !=0)
    cps_val = (intermediate / 53) + 1;
else
    cps_val = (intermediate / 53);
```

Note Observed traffic-shaping rates may vary as much as 2% from the values listed in these tables.

Table 23-2 shows the DS3, E3, E1, and T1 rates for best-effort connections and VBR connections when shaped using PCR-only mode.

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second)

105510	105439	104946	104458	103974	103495	103021	102550	102084
101622	101164	100711	100261	99815	99374	98936	98502	98072

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

97646	97223	96804	96388	95976	95568	95163	94762	94363
93969	93577	93189	92804	92422	92043	91667	91295	90925
90558	90195	89834	89476	89121	88769	88419	88073	87728
87387	87048	86712	86379	86048	85719	85394	85070	84749
84430	84114	83800	83489	83180	82873	82568	82266	81965
81667	81371	81078	80786	80496	80209	79924	79640	79359
79079	78802	78526	78253	77981	77711	77443	77177	76913
76650	76390	76131	75873	75618	75364	75112	74862	74613
74366	74121	73877	73634	73394	73155	72917	72681	72447
72214	71982	71752	71524	71297	71071	70847	70624	70403
70183	69964	69747	69531	69316	69103	68891	68681	68471
68263	68056	67851	67646	67443	67241	67040	66841	66643
66445	66249	66055	65861	65668	65477	65286	65097	64909
64722	64536	64351	64167	63984	63803	63622	63442	63264
63086	62909	62733	62559	62385	62212	62040	61869	61699
61530	61362	61195	61029	60863	60699	60535	60372	60211
60050	59889	59730	59572	59414	59257	59101	58946	58792
58639	58486	58334	58183	58032	57883	57734	57586	57439
57292	57146	57001	56857	56714	56571	56429	56287	56146
56006	55867	55728	55591	55453	55317	55181	55046	54911
54777	54644	54511	54379	54248	54117	53987	53857	53729
53600	53473	53346	53219	53094	52968	52844	52720	52596
52473	52351	52229	52108	51987	51867	51748	51629	51511
51393	51275	51159	51042	50927	50811	50697	50582	50469
50356	50243	50131	50019	49908	49797	49687	49577	49468
49360	49251	49144	49036	48929	48823	48717	48612	48507
48402	48298	48194	48091	47988	47886	47784	47683	47582
47481	47381	47281	47182	47083	46985	46886	46789	46691
46595	46498	46402	46306	46211	46116	46022	45928	45834
45741	45648	45555	45463	45371	45279	45188	45098	45007
44917	44828	44738	44649	44561	44473	44385	44297	44210
44123	44037	43950	43864	43779	43694	43609	43524	43440
43356	43273	43190	43107	43024	42942	42860	42778	42697
42616	42535	42455	42375	42295	42215	42136	42057	41979
41900	41822	41745	41667	41590	41513	41437	41360	41284
41209	41133	41058	40983	40908	40834	40760	40686	40612

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

40539	40466	40393	40321	40248	40176	40105	40033	39962
39891	39820	39750	39680	39610	39540	39470	39401	39332
39263	39195	39127	39059	38991	38923	38856	38789	38722
38655	38589	38523	38457	38391	38325	38260	38195	38130
38066	38001	37937	37873	37809	37746	37682	37619	37556
37494	37431	37369	37307	37245	37183	37122	37061	36999
36939	36878	36817	36757	36697	36637	36578	36518	36459
36400	36341	36282	36224	36165	36107	36049	35991	35934
35876	35819	35762	35705	35649	35592	35536	35480	35424
35368	35312	35257	35202	35147	35092	35037	34982	34928
34874	34820	34766	34712	34658	34605	34552	34499	34446
34393	34341	34288	34236	34184	34132	34080	34028	33977
33926	33874	33823	33772	33722	33671	33621	33571	33520
33470	33421	33371	33322	33272	33223	33174	33125	33076
33028	32979	32931	32882	32834	32786	32739	32691	32643
32596	32549	32502	32455	32408	32361	32315	32268	32222
32176	32130	32084	32038	31992	31947	31902	31856	31811
31766	31721	31677	31632	31588	31543	31499	31455	31411
31367	31323	31280	31236	31193	31149	31106	31063	31020
30978	30935	30892	30850	30808	30765	30723	30681	30639
30598	30556	30515	30473	30432	30391	30350	30309	30268
30227	30186	30146	30106	30065	30025	29985	29945	29905
29865	29826	29786	29747	29707	29668	29629	29590	29551
29512	29473	29435	29396	29358	29320	29281	29243	29205
29167	29129	29092	29054	29016	28979	28942	28904	28867
28830	28793	28756	28720	28683	28646	28610	28573	28537
28501	28465	28429	28393	28357	28321	28286	28250	28215
28179	28144	28109	28073	28038	28003	27969	27934	27899
27864	27830	27796	27761	27727	27693	27659	27625	27591
27557	27523	27489	27456	27422	27389	27355	27322	27289
27256	27223	27190	27157	27124	27091	27059	27026	26994
26961	26929	26897	26865	26832	26800	26769	26737	26705
26673	26642	26610	26578	26547	26516	26484	26453	26422
26391	26360	26329	26298	26268	26237	26206	26176	26145
26115	26085	26054	26024	25994	25964	25934	25904	25874
25844	25815	25785	25756	25726	25697	25667	25638	25609

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

25580	25550	25521	25492	25464	25435	25406	25377	25349
25320	25291	25263	25235	25206	25178	25150	25122	25094
25066	25038	25010	24982	24954	24927	24899	24871	24844
24816	24789	24762	24734	24707	24680	24653	24626	24599
24572	24545	24518	24492	24465	24438	24412	24385	24359
24332	24306	24280	24254	24227	24201	24175	24149	24123
24097	24072	24046	24020	23994	23969	23943	23918	23892
23867	23842	23816	23791	23766	23741	23716	23691	23666
23641	23616	23591	23566	23542	23517	23493	23468	23443
23419	23395	23370	23346	23322	23298	23273	23249	23225
23201	23177	23153	23130	23106	23082	23058	23035	23011
22988	22964	22941	22917	22894	22871	22847	22824	22801
22778	22755	22732	22709	22686	22663	22640	22617	22594
22572	22549	22526	22504	22481	22459	22436	22414	22392
22369	22347	22325	22303	22281	22259	22237	22215	22193
22171	22149	22127	22105	22083	22062	22040	22019	21997
21975	21954	21932	21911	21890	21868	21847	21826	21805
21784	21762	21741	21720	21699	21678	21658	21637	21616
21595	21574	21554	21533	21512	21492	21471	21451	21430
21410	21389	21369	21349	21328	21308	21288	21268	21248
21228	21208	21188	21168	21148	21128	21108	21088	21068
21049	21029	21009	20990	20970	20950	20931	20911	20892
20873	20853	20834	20815	20795	20776	20757	20738	20719
20699	20680	20661	20642	20623	20605	20586	20567	20548
20529	20510	20492	20473	20454	20436	20417	20399	20380
20362	20343	20325	20306	20288	20270	20252	20233	20215
20197	20179	20161	20143	20124	20106	20088	20071	20053
20035	20017	19999	19981	19963	19946	19928	19910	19893
19875	19858	19840	19823	19805	19788	19770	19753	19735
19718	19701	19684	19666	19649	19632	19615	19598	19581
19564	19547	19530	19513	19496	19479	19462	19445	19428
19411	19395	19378	19361	19344	19328	19311	19295	19278
19262	19245	19229	19212	19196	19179	19163	19147	19130
19114	19098	19082	19065	19049	19033	19017	19001	18985
18969	18953	18937	18921	18905	18889	18873	18857	18841
18826	18810	18794	18778	18763	18747	18731	18716	18700

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

18685	18669	18654	18638	18623	18607	18592	18576	18561
18546	18531	18515	18500	18485	18470	18454	18439	18424
18409	18394	18379	18364	18349	18334	18319	18304	18289
18274	18259	18245	18230	18215	18200	18185	18171	18156
18141	18127	18112	18097	18083	18068	18054	18039	18025
18010	17996	17982	17967	17953	17938	17924	17910	17896
17881	17867	17853	17839	17825	17810	17796	17782	17768
17754	17740	17726	17712	17698	17684	17670	17656	17643
17629	17615	17601	17587	17574	17560	17546	17532	17519
17505	17491	17478	17464	17451	17437	17424	17410	17397
17383	17370	17356	17343	17329	17316	17303	17289	17276
17263	17250	17236	17223	17210	17197	17184	17171	17157
17144	17131	17118	17105	17092	17079	17066	17053	17040
17027	17014	17002	16989	16976	16963	16950	16937	16925
16912	16899	16886	16874	16861	16848	16836	16823	16811
16798	16786	16773	16760	16748	16735	16723	16711	16698
16686	16673	16661	16649	16636	16624	16612	16599	16587
16575	16563	16551	16538	16526	16514	16502	16490	16478
16466	16454	16441	16429	16417	16405	16393	16382	16370
16358	16346	16334	16322	16310	16298	16286	16275	16263
16251	16239	16228	16216	16204	16193	16181	16169	16158
16146	16134	16123	16111	16100	16088	16077	16065	16054
16042	16031	16019	16008	15996	15985	15974	15962	15951
15940	15928	15917	15906	15895	15883	15872	15861	15850
15839	15827	15816	15805	15794	15783	15772	15761	15750
15739	15728	15717	15706	15695	15684	15673	15662	15651
15640	15629	15618	15607	15597	15586	15575	15564	15553
15543	15532	15521	15510	15500	15489	15478	15468	15457
15446	15436	15425	15415	15404	15393	15383	15372	15362
15351	15341	15330	15320	15310	15299	15289	15278	15268
15258	15247	15237	15227	15216	15206	15196	15185	15175
15165	15155	15144	15134	15124	15114	15104	15093	15083
15073	15063	15053	15043	15033	15023	15013	15003	14993
14983	14973	14963	14953	14943	14933	14923	14913	14903
14893	14883	14874	14864	14854	14844	14834	14825	14815
14805	14795	14785	14776	14766	14756	14747	14737	14727

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

14718	14708	14698	14689	14679	14670	14660	14650	14641
14631	14622	14612	14603	14593	14584	14574	14565	14556
14546	14537	14527	14518	14508	14499	14490	14480	14471
14462	14452	14443	14434	14425	14415	14406	14397	14388
14378	14369	14360	14351	14342	14333	14323	14314	14305
14296	14287	14278	14269	14260	14251	14242	14233	14224
14215	14206	14197	14188	14179	14170	14161	14152	14143
14134	14125	14116	14108	14099	14090	14081	14072	14063
14055	14046	14037	14028	14019	14011	14002	13993	13985
13976	13967	13958	13950	13941	13932	13924	13915	13907
13898	13889	13881	13872	13864	13855	13847	13838	13830
13821	13813	13804	13796	13787	13779	13770	13762	13753
13745	13737	13728	13720	13711	13703	13695	13686	13678
13670	13661	13653	13645	13636	13628	13620	13612	13603
13595	13587	13579	13571	13562	13554	13546	13538	13530
13521	13513	13505	13497	13489	13481	13473	13465	13457
13449	13441	13433	13425	13416	13408	13400	13392	13385
13377	13369	13361	13353	13345	13337	13329	13321	13313
13305	13297	13289	13282	13274	13266	13258	13250	13242
13235	13227	13219	13211	13204	13196	13188	13180	13173
13165	13157	13149	13142	13134	13126	13119	13111	13103
13096	13088	13081	13073	13065	13058	13050	13043	13035
13027	13020	13012	13005	12997	12990	12982	12975	12967
12960	12952	12945	12937	12930	12922	12915	12908	12900
12893	12885	12878	12871	12863	12856	12849	12841	12834
12827	12819	12812	12805	12797	12790	12783	12775	12768
12761	12754	12746	12739	12732	12725	12718	12710	12703
12696	12689	12682	12675	12667	12660	12653	12646	12639
12632	12625	12618	12610	12603	12596	12589	12582	12575
12568	12561	12554	12547	12540	12533	12526	12519	12512
12505	12498	12491	12484	12477	12470	12464	12457	12450
12443	12436	12429	12422	12415	12408	12402	12395	12388
12381	12374	12367	12361	12354	12347	12340	12333	12327
12320	12313	12306	12300	12293	12286	12280	12273	12266
12259	12253	12246	12239	12233	12226	12219	12213	12206
12200	12193	12186	12180	12173	12166	12160	12153	12147

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

12140	12134	12127	12121	12114	12107	12101	12094	12088
12081	12075	12068	12062	12055	12049	12043	12036	12030
12023	12017	12010	12004	11997	11991	11985	11978	11972
11966	11959	11953	11946	11940	11934	11927	11921	11915
11908	11902	11896	11890	11883	11877	11871	11864	11858
11852	11846	11839	11833	11827	11821	11814	11808	11802
11796	11790	11783	11777	11771	11765	11759	11753	11747
11740	11734	11728	11722	11716	11710	11704	11698	11691
11685	11679	11673	11667	11661	11655	11649	11643	11637
11631	11625	11619	11613	11607	11601	11595	11589	11583
11577	11571	11565	11559	11553	11547	11541	11535	11529
11524	11518	11512	11506	11500	11494	11488	11482	11476
11471	11465	11459	11453	11447	11441	11436	11430	11424
11418	11412	11406	11401	11395	11389	11383	11378	11372
11366	11360	11355	11349	11343	11337	11332	11326	11320
11315	11309	11303	11297	11292	11286	11280	11275	11269
11263	11258	11252	11247	11241	11235	11230	11224	11218
11213	11207	11202	11196	11191	11185	11179	11174	11168
11163	11157	11152	11146	11141	11135	11130	11124	11119
11113	11108	11102	11097	11091	11086	11080	11075	11069
11064	11058	11053	11047	11042	11037	11031	11026	11020
11015	11010	11004	10999	10993	10988	10983	10977	10972
10966	10961	10956	10950	10945	10940	10934	10929	10924
10919	10913	10908	10903	10897	10892	10887	10881	10876
10871	10866	10860	10855	10850	10845	10839	10834	10829
10824	10819	10813	10808	10803	10798	10793	10787	10782
10777	10772	10767	10762	10756	10751	10746	10741	10736
10731	10726	10720	10715	10710	10705	10700	10695	10690
10685	10680	10675	10670	10664	10659	10654	10649	10644
10639	10634	10629	10624	10619	10614	10609	10604	10599
10594	10589	10584	10579	10574	10569	10564	10559	10554
10549	10544	10539	10534	10530	10525	10520	10515	10510
10505	10500	10495	10490	10485	10480	10475	10471	10466
10461	10456	10451	10446	10441	10437	10432	10427	10422
10417	10412	10408	10403	10398	10393	10388	10383	10379
10374	10369	10364	10360	10355	10350	10345	10340	10336

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

10331	10326	10321	10317	10312	10307	10303	10298	10293
10288	10284	10279	10274	10270	10265	10260	10255	10251
10246	10241	10237	10232	10227	10223	10218	10213	10209
10204	10200	10195	10190	10186	10181	10176	10172	10167
10163	10158	10153	10149	10144	10140	10135	10131	10126
10121	10117	10112	10108	10103	10099	10094	10090	10085
10081	10076	10072	10067	10062	10058	10053	10049	10044
10040	10036	10031	10027	10022	10018	10013	10009	10004
10000	9995	9991	9986	9982	9978	9973	9969	9964
9960	9955	9951	9947	9942	9938	9933	9929	9925
9920	9916	9912	9907	9903	9898	9894	9890	9885
9881	9877	9872	9868	9864	9859	9855	9851	9846
9842	9838	9833	9829	9825	9821	9816	9812	9808
9803	9799	9795	9791	9786	9782	9778	9774	9769
9765	9761	9757	9752	9748	9744	9740	9735	9731
9727	9723	9719	9714	9710	9706	9702	9698	9693
9689	9685	9681	9677	9672	9668	9664	9660	9656
9652	9648	9643	9639	9635	9631	9627	9623	9619
9615	9610	9606	9602	9598	9594	9590	9586	9582
9578	9574	9569	9565	9561	9557	9553	9549	9545
9541	9537	9533	9529	9525	9521	9517	9513	9509
9505	9501	9497	9493	9489	9485	9481	9477	9473
9469	9465	9461	9457	9453	9449	9445	9441	9437
9433	9429	9425	9421	9417	9413	9409	9405	9401
9397	9393	9389	9386	9382	9378	9374	9370	9366
9362	9358	9354	9350	9346	9343	9339	9335	9331
9327	9323	9319	9315	9312	9308	9304	9300	9296
9292	9288	9285	9281	9277	9273	9269	9266	9262
9258	9254	9250	9246	9243	9239	9235	9231	9227
9224	9220	9216	9212	9209	9205	9201	9197	9193
9190	9186	9182	9178	9175	9171	9167	9163	9160
9156	9152	9149	9145	9141	9137	9134	9130	9126
9123	9119	9115	9111	9108	9104	9100	9097	9093
9089	9086	9082	9078	9075	9071	9067	9064	9060
9056	9053	9049	9045	9042	9038	9034	9031	9027
9024	9020	9016	9013	9009	9005	9002	8998	8995

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

8991	8987	8984	8980	8977	8973	8969	8966	8962
8959	8955	8952	8948	8944	8941	8937	8934	8930
8927	8923	8920	8916	8913	8909	8905	8902	8898
8895	8891	8888	8884	8881	8877	8874	8870	8867
8863	8860	8856	8853	8849	8846	8842	8839	8835
8832	8828	8825	8822	8818	8815	8811	8808	8804
8801	8797	8794	8790	8787	8784	8780	8777	8773
8770	8766	8763	8760	8756	8753	8749	8746	8743
8739	8736	8732	8729	8726	8722	8719	8715	8712
8709	8705	8702	8699	8695	8692	8688	8685	8682
8678	8675	8672	8668	8665	8662	8658	8655	8652
8648	8645	8642	8638	8635	8632	8628	8625	8622
8618	8615	8612	8609	8605	8602	8599	8595	8592
8589	8586	8582	8579	8576	8572	8569	8566	8563
8559	8556	8553	8550	8546	8543	8540	8537	8533
8530	8527	8524	8520	8517	8514	8511	8507	8504
8501	8498	8495	8491	8488	8485	8482	8479	8475
8472	8469	8466	8463	8459	8456	8453	8450	8447
8443	8440	8437	8434	8431	8428	8424	8421	8418
8415	8412	8409	8406	8402	8399	8396	8393	8390
8387	8384	8380	8377	8374	8371	8368	8365	8362
8359	8356	8352	8349	8346	8343	8340	8337	8334
8331	8328	8325	8321	8318	8315	8312	8309	8306
8303	8300	8297	8294	8291	8288	8285	8282	8279
8276	8272	8269	8266	8263	8260	8257	8254	8251
8248	8245	8242	8239	8236	8233	8230	8227	8224
8221	8218	8215	8212	8209	8206	8203	8200	8197
8194	8191	8188	8185	8182	8179	8176	8173	8170
8167	8164	8161	8158	8155	8152	8149	8146	8143
8141	8138	8135	8132	8129	8126	8123	8120	8117
8114	8111	8108	8105	8102	8099	8097	8094	8091
8088	8085	8082	8079	8076	8073	8070	8067	8065
8062	8059	8056	8053	8050	8047	8044	8041	8039
8036	8033	8030	8027	8024	8021	8018	8016	8013
8010	8007	8004	8001	7998	7996	7993	7990	7987
7984	7981	7979	7976	7973	7970	7967	7964	7962

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

7959	7956	7953	7950	7948	7945	7942	7939	7936
7934	7931	7928	7925	7922	7920	7917	7914	7911
7908	7906	7903	7900	7897	7894	7892	7889	7886
7883	7881	7878	7875	7872	7870	7867	7864	7861
7859	7856	7853	7850	7848	7845	7842	7839	7837
7834	7831	7828	7826	7823	7820	7818	7815	7812
7809	7807	7804	7801	7799	7796	7793	7790	7788
7785	7782	7780	7777	7774	7772	7769	7766	7764
7761	7758	7755	7753	7750	7747	7745	7742	7739
7737	7734	7731	7729	7726	7723	7721	7718	7716
7713	7710	7708	7705	7702	7700	7697	7694	7692
7689	7686	7684	7681	7679	7676	7673	7671	7668
7665	7663	7660	7658	7655	7652	7650	7647	7645
7642	7639	7637	7634	7632	7629	7626	7624	7621
7619	7616	7614	7611	7608	7606	7603	7601	7598
7595	7593	7590	7588	7585	7583	7580	7578	7575
7572	7570	7567	7565	7562	7560	7557	7555	7552
7550	7547	7544	7542	7539	7537	7534	7532	7529
7527	7524	7522	7519	7517	7514	7512	7509	7507
7504	7502	7499	7497	7494	7492	7489	7487	7484
7482	7479	7477	7474	7472	7469	7467	7464	7462
7459	7457	7454	7452	7449	7447	7444	7442	7440
7437	7435	7432	7430	7427	7425	7422	7420	7417
7415	7413	7410	7408	7405	7403	7400	7398	7395
7393	7391	7388	7386	7383	7381	7378	7376	7374
7371	7369	7366	7364	7361	7359	7357	7354	7352
7349	7347	7345	7342	7340	7337	7335	7333	7330
7328	7325	7323	7321	7318	7316	7314	7311	7309
7306	7304	7302	7299	7297	7295	7292	7290	7287
7285	7283	7280	7278	7276	7273	7271	7269	7266
7264	7262	7259	7257	7254	7252	7250	7247	7245
7243	7240	7238	7236	7233	7231	7229	7226	7224
7222	7220	7217	7215	7213	7210	7208	7206	7203
7201	7199	7196	7194	7192	7189	7187	7185	7183
7180	7178	7176	7173	7171	7169	7167	7164	7162
7160	7157	7155	7153	7151	7148	7146	7144	7141

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

7139	7137	7135	7132	7130	7128	7126	7123	7121
7119	7117	7114	7112	7110	7108	7105	7103	7101
7099	7096	7094	7092	7090	7087	7085	7083	7081
7078	7076	7074	7072	7070	7067	7065	7063	7061
7058	7056	7054	7052	7050	7047	7045	7043	7041
7039	7036	7034	7032	7030	7028	7025	7023	7021
7019	7017	7014	7012	7010	7008	7006	7003	7001
6999	6997	6995	6993	6990	6988	6986	6984	6982
6979	6977	6975	6973	6971	6969	6966	6964	6962
6960	6958	6956	6954	6951	6949	6947	6945	6943
6941	6939	6936	6934	6932	6930	6928	6926	6924
6921	6919	6917	6915	6913	6911	6909	6907	6904
6902	6900	6898	6896	6894	6892	6890	6887	6885
6883	6881	6879	6877	6875	6873	6871	6869	6866
6864	6862	6860	6858	6856	6854	6852	6850	6848
6845	6843	6841	6839	6837	6835	6833	6831	6829
6827	6825	6823	6821	6818	6816	6814	6812	6810
6808	6806	6804	6802	6800	6798	6796	6794	6792
6790	6788	6786	6783	6781	6779	6777	6775	6773
6771	6769	6767	6765	6763	6761	6759	6757	6755
6753	6751	6749	6747	6745	6743	6741	6739	6737
6735	6733	6731	6729	6727	6725	6723	6721	6719
6717	6715	6713	6710	6708	6706	6704	6702	6700
6698	6696	6694	6693	6691	6689	6687	6685	6683
6681	6679	6677	6675	6673	6671	6669	6667	6665
6663	6661	6659	6657	6655	6653	6651	6649	6647
6645	6643	6641	6639	6637	6635	6633	6631	6629
6627	6625	6623	6621	6620	6618	6616	6614	6612
6610	6608	6606	6604	6602	6600	6598	6596	6594
6592	6590	6588	6587	6585	6583	6581	6579	6577
6575	6573	6571	6569	6567	6565	6563	6562	6560
6558	6556	6554	6552	6550	6548	6546	6544	6542
6541	6539	6537	6535	6533	6531	6529	6527	6525
6523	6522	6520	6518	6516	6514	6512	6510	6508
6506	6505	6503	6501	6499	6497	6495	6493	6491
6489	6488	6486	6484	6482	6480	6478	6476	6475

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

6473	6471	6469	6467	6465	6463	6461	6460	6458
6456	6454	6452	6450	6448	6447	6445	6443	6441
6439	6437	6436	6434	6432	6430	6428	6426	6425
6423	6421	6419	6417	6415	6414	6412	6410	6408
6406	6404	6403	6401	6399	6397	6395	6393	6392
6390	6388	6386	6384	6383	6381	6379	6377	6375
6373	6372	6370	6368	6366	6364	6363	6361	6359
6357	6355	6354	6352	6350	6348	6346	6345	6343
6341	6339	6338	6336	6334	6332	6330	6329	6327
6325	6323	6321	6320	6318	6316	6314	6313	6311
6309	6307	6305	6304	6302	6300	6298	6297	6295
6293	6291	6290	6288	6286	6284	6283	6281	6279
6277	6276	6274	6272	6270	6269	6267	6265	6263
6262	6260	6258	6256	6255	6253	6251	6249	6248
6246	6244	6242	6241	6239	6237	6235	6234	6232
6230	6229	6227	6225	6223	6222	6220	6218	6216
6215	6213	6211	6210	6208	6206	6204	6203	6201
6199	6198	6196	6194	6192	6191	6189	6187	6186
6184	6182	6181	6179	6177	6175	6174	6172	6170
6169	6167	6165	6164	6162	6160	6159	6157	6155
6153	6152	6150	6148	6147	6145	6143	6142	6140
6138	6137	6135	6133	6132	6130	6128	6127	6125
6123	6122	6120	6118	6117	6115	6113	6112	6110
6108	6107	6105	6103	6102	6100	6098	6097	6095
6093	6092	6090	6088	6087	6085	6083	6082	6080
6079	6077	6075	6074	6072	6070	6069	6067	6065
6064	6062	6061	6059	6057	6056	6054	6052	6051
6049	6047	6046	6044	6043	6041	6039	6038	6036
6034	6033	6031	6030	6028	6026	6025	6023	6022
6020	6018	6017	6015	6013	6012	6010	6009	6007
6005	6004	6002	6001	5999	5997	5996	5994	5993
5991	5989	5988	5986	5985	5983	5981	5980	5978
5977	5975	5973	5972	5970	5969	5967	5966	5964
5962	5961	5959	5958	5956	5954	5953	5951	5950
5948	5947	5945	5943	5942	5940	5939	5937	5936
5934	5932	5931	5929	5928	5926	5925	5923	5922

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

5920	5918	5917	5915	5914	5912	5911	5909	5907
5906	5904	5903	5901	5900	5898	5897	5895	5894
5892	5890	5889	5887	5886	5884	5883	5881	5880
5878	5877	5875	5874	5872	5870	5869	5867	5866
5864	5863	5861	5860	5858	5857	5855	5854	5852
5851	5849	5848	5846	5844	5843	5841	5840	5838
5837	5835	5834	5832	5831	5829	5828	5826	5825
5823	5822	5820	5819	5817	5816	5814	5813	5811
5810	5808	5807	5805	5804	5802	5801	5799	5798
5796	5795	5793	5792	5790	5789	5787	5786	5784
5783	5781	5780	5778	5777	5775	5774	5772	5771
5769	5768	5766	5765	5763	5762	5761	5759	5758
5756	5755	5753	5752	5750	5749	5747	5746	5744
5743	5741	5740	5738	5737	5736	5734	5733	5731
5730	5728	5727	5725	5724	5722	5721	5719	5718
5717	5715	5714	5712	5711	5709	5708	5706	5705
5703	5702	5701	5699	5698	5696	5695	5693	5692
5690	5689	5688	5686	5685	5683	5682	5680	5679
5678	5676	5675	5673	5672	5670	5669	5668	5666
5665	5663	5662	5660	5659	5658	5656	5655	5653
5652	5650	5649	5648	5646	5645	5643	5642	5640
5639	5638	5636	5635	5633	5632	5631	5629	5628
5626	5625	5624	5622	5621	5619	5618	5616	5615
5614	5612	5611	5609	5608	5607	5605	5604	5602
5601	5600	5598	5597	5596	5594	5593	5591	5590
5589	5587	5586	5584	5583	5582	5580	5579	5577
5576	5575	5573	5572	5571	5569	5568	5566	5565
5564	5562	5561	5560	5558	5557	5555	5554	5553
5551	5550	5549	5547	5546	5544	5543	5542	5540
5539	5538	5536	5535	5533	5532	5531	5529	5528
5527	5525	5524	5523	5521	5520	5519	5517	5516
5514	5513	5512	5510	5509	5508	5506	5505	5504
5502	5501	5500	5498	5497	5496	5494	5493	5492
5490	5489	5488	5486	5485	5483	5399	5317	5238
5161	5086	5014	4943	4874	4808	4743	4679	4618
4558	4499	4442	4387	4333	4280	4228	4178	4129

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

4081	4034	3988	3943	3900	3857	3815	3774	3734
3694	3656	3618	3581	3545	3510	3475	3441	3407
3375	3343	3311	3280	3250	3220	3191	3162	3134
3106	3079	3052	3026	3000	2974	2949	2925	2901
2877	2853	2830	2808	2786	2764	2742	2721	2700
2679	2659	2639	2619	2600	2581	2562	2543	2525
2507	2489	2472	2454	2437	2421	2404	2388	2372
2356	2340	2324	2309	2294	2279	2264	2250	2236
2221	2207	2194	2180	2167	2153	2140	2127	2114
2102	2089	2077	2065	2053	2041	2029	2017	2006
1994	1983	1972	1961	1950	1939	1929	1918	1908
1897	1887	1877	1867	1857	1847	1838	1828	1819
1809	1800	1791	1782	1773	1764	1755	1746	1738
1729	1721	1712	1704	1696	1688	1680	1672	1664
1656	1648	1640	1633	1625	1618	1610	1603	1596
1588	1581	1574	1567	1560	1553	1546	1540	1533
1526	1520	1513	1507	1500	1494	1487	1481	1475
1469	1463	1457	1451	1445	1439	1433	1427	1421
1415	1410	1404	1399	1393	1388	1382	1377	1371
1366	1361	1355	1350	1345	1340	1335	1330	1325
1320	1315	1310	1305	1300	1295	1291	1286	1281
1277	1272	1267	1263	1258	1254	1249	1245	1240
1236	1232	1227	1223	1219	1215	1211	1206	1202
1198	1194	1190	1186	1182	1178	1174	1170	1166
1162	1159	1155	1151	1147	1144	1140	1136	1132
1129	1125	1122	1118	1115	1111	1107	1104	1101
1097	1094	1090	1087	1084	1080	1077	1074	1070
1067	1064	1061	1057	1054	1051	1048	1045	1042
1039	1036	1033	1030	1027	1024	1021	1018	1015
1012	1009	1006	1003	1000	997	995	992	989
986	983	981	978	975	973	970	967	965
962	959	957	954	951	949	946	944	941
939	936	934	931	929	926	924	922	919
917	914	912	910	907	905	903	900	898
896	893	891	889	887	884	882	880	878
876	873	871	869	867	865	863	861	858

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

856	854	852	850	848	846	844	842	840
838	836	834	832	830	828	826	824	822
820	818	817	815	813	811	809	807	805
804	802	800	798	796	794	793	791	789
787	786	784	782	780	779	777	775	773
772	770	768	767	765	763	762	760	758
757	755	754	752	750	749	747	746	744
742	741	739	738	736	735	733	732	730
729	727	726	724	723	721	720	718	717
715	714	712	711	709	708	707	705	704
702	701	700	698	697	695	694	693	691
690	689	687	686	685	683	682	681	679
678	677	675	674	673	671	670	669	668
666	665	664	663	661	660	659	658	656
655	654	653	652	650	649	648	647	646
644	643	642	641	640	639	637	636	635
634	633	632	631	629	628	627	626	625
624	623	622	620	619	618	617	616	615
614	613	612	611	610	609	608	607	606
604	603	602	601	600	599	598	597	596
595	594	593	592	591	590	589	588	587
586	585	584	583	582	581	580	579	578
577	576	575	574	573	572	571	570	569
568	567	566	565	564	563	562	561	560
559	558	557	556	555	554	553	552	551
550	549	548	547	546	545	544	543	542
541	540	539	538	537	536	535	534	533
532	531	530	529	528	527	526	525	524
523	522	521	520	519	518	517	516	515
514	513	512	511	510	509	508	507	506
505	504	503	502	501	500	499	498	497
496	495	494	493	492	491	490	489	488
487	486	485	484	483	482	481	480	479
478	477	476	475	474	473	472	471	470
469	468	467	466	465	464	463	462	461
460	459	458	457	456	455	454	453	452

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

451	450	449	448	447	446	445	444	443
442	441	440	439	438	437	436	435	434
433	432	431	430	429	428	427	426	425
424	423	422	421	420	419	418	417	416
415	414	413	412	411	410	409	408	407
406	405	404	403	402	401	400	399	398
397	396	395	394	393	392	391	390	389
388	387	386	385	384	383	382	381	380
379	378	377	376	375	374	373	372	371
370	369	368	367	366	365	364	363	362
361	360	359	358	357	356	355	354	353
352	351	350	349	348	347	346	345	344
343	342	341	340	339	338	337	336	335
334	333	332	331	330	329	328	327	326
325	324	323	322	321	320	319	318	317
316	315	314	313	312	311	310	309	308
307	306	305	304	303	302	301	300	299
298	297	296	295	294	293	292	291	290
289	288	287	286	285	284	283	282	281
280	279	278	277	276	275	274	273	272
271	270	269	268	267	266	265	264	263
262	261	260	259	258	257	256	255	254
253	252	251	250	249	248	247	246	245
244	243	242	241	240	239	238	237	236
235	234	233	232	231	230	229	228	227
226	225	224	223	222	221	220	219	218
217	216	215	214	213	212	211	210	209
208	207	206	205	204	203	202	201	200
199	198	197	196	195	194	193	192	191
190	189	188	187	186	185	184	183	182
181	180	179	178	177	176	175	174	173
172	171	170	169	168	167	166	165	164
163	162	161	160	159	158	157	156	155
154	153	152	151	150	149	148	147	146
145	144	143	142	141	140	139	138	137
136	135	134	133	132	131	130	129	128

Table 23-2 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for DS3, E3, E1, and T1 (Cells Per Second) (continued)

127	126	125	124	123	122	121	120	119
118	117	116	115	114	113	112	111	110
109	108	107	106	105	104	103	102	101
100	99	98	97	96	95	94	93	92
91	90	89	88	87	86			

Table 23-3 shows the DS3, E3, E1 and T1 rates for VBR connections that are shaped using their PCR, SCR and MBS parameters (the default shaping mode).

Table 23-3 VBR Shaping (Using PCR, SCR and MBS) Values for DS3, E3, E1, and T1 (Cells Per Second)

105510	87728	70183	58486	50131	43864	38991	35092	31902	29243
26994	25066	23395	21932	20642	19496	18470	17546	16711	15951
15258	14622	14037	13497	12997	12533	12101	11698	11320	10966
10634	10321	10027	9748	9485	9235	8998	8773	8559	8356
8161	7976	7799	7629	7467	7311	7162	7019	6881	6749
6621	6499	6381	6267	6157	6051	5948	5849	5753	5660
5571	5483	5399	5317	5238	5161	5086	5014	4943	4874
4808	4743	4679	4618	4558	4499	4442	4387	4333	4280
4228	4178	4129	4081	4034	3988	3943	3900	3857	3815
3774	3734	3694	3656	3618	3581	3545	3510	3475	3441
3407	3375	3343	3311	3280	3250	3220	3191	3162	3134
3106	3079	3052	3026	3000	2974	2949	2925	2901	2877
2853	2830	2808	2786	2764	2742	2721	2700	2679	2659
2639	2619	2600	2581	2562	2543	2525	2507	2489	2472
2454	2437	2421	2404	2388	2372	2356	2340	2324	2309
2294	2279	2264	2250	2236	2221	2207	2194	2180	2167
2153	2140	2127	2114	2102	2089	2077	2065	2053	2041
2029	2017	2006	1994	1983	1972	1961	1950	1939	1929
1918	1908	1897	1887	1877	1867	1857	1847	1838	1828
1819	1809	1800	1791	1782	1773	1764	1755	1746	1738
1729	1721	1712	1704	1696	1688	1680	1672	1664	1656
1648	1640	1633	1625	1618	1610	1603	1596	1588	1581
1574	1567	1560	1553	1546	1540	1533	1526	1520	1513
1507	1500	1494	1487	1481	1475	1469	1463	1457	1451
1445	1439	1433	1427	1421	1415	1410	1404	1399	1393
1388	1382	1377	1371	1366	1361	1355	1350	1345	1340

Table 23-3 VBR Shaping (Using PCR, SCR and MBS) Values for DS3, E3, E1, and T1 (Cells Per Second) (continued)

1335	1330	1325	1320	1315	1310	1305	1300	1295	1291
1286	1281	1277	1272	1267	1263	1258	1254	1249	1245
1240	1236	1232	1227	1223	1219	1215	1211	1206	1202
1198	1194	1190	1186	1182	1178	1174	1170	1166	1162
1159	1155	1151	1147	1144	1140	1136	1132	1129	1125
1122	1118	1115	1111	1107	1104	1101	1097	1094	1090
1087	1084	1080	1077	1074	1070	1067	1064	1061	1057
1054	1051	1048	1045	1042	1039	1036	1033	1030	1027
1024	1021	1018	1015	1012	1009	1006	1003	1000	997
995	992	989	986	983	981	978	975	973	970
967	965	962	959	957	954	951	949	946	944
941	939	936	934	931	929	926	924	922	919
917	914	912	910	907	905	903	900	898	896
893	891	889	887	884	882	880	878	876	873
871	869	867	865	863	861	858	856	854	852
850	848	846	844	842	840	838	836	834	832
830	828	826	824	822	820	818	817	815	813
811	809	807	805	804	802	800	798	796	794
793	791	789	787	786	784	782	780	779	777
775	773	772	770	768	767	765	763	762	760
758	757	755	754	752	750	749	747	746	744
742	741	739	738	736	735	733	732	730	729
727	726	724	723	721	720	718	717	715	714
712	711	709	708	707	705	704	702	701	700
698	697	695	694	693	691	690	689	687	686
685	683	682	681	679	678	677	675	674	673
671	670	669	668	666	665	664	663	661	660
659	658	656	655	654	653	652	650	649	648
647	646	644	643	642	641	640	639	637	636
635	634	633	632	631	629	628	627	626	625
624	623	622	620	619	618	617	616	615	614
613	612	611	610	609	608	607	606	604	603
602	601	600	599	598	597	596	595	594	593
592	591	590	589	588	587	586	585	584	583
582	581	580	579	578	577	576	575	574	573
572	571	570	569	568	567	566	565	564	563

Table 23-3 VBR Shaping (Using PCR, SCR and MBS) Values for DS3, E3, E1, and T1 (Cells Per Second) (continued)

562	561	560	559	558	557	556	555	554	553
552	551	550	549	548	547	546	545	544	543
542	541	540	539	538	537	536	535	534	533
532	531	530	529	528	527	526	525	524	523
522	521	520	519	518	517	516	515	514	513
512	511	510	509	508	507	506	505	504	503
502	501	500	499	498	497	496	495	494	493
492	491	490	489	488	487	486	485	484	483
482	481	480	479	478	477	476	475	474	473
472	471	470	469	468	467	466	465	464	463
462	461	460	459	458	457	456	455	454	453
452	451	450	449	448	447	446	445	444	443
442	441	440	439	438	437	436	435	434	433
432	431	430	429	428	427	426	425	424	423
422	421	420	419	418	417	416	415	414	413
412	411	410	409	408	407	406	405	404	403
402	401	400	399	398	397	396	395	394	393
392	391	390	389	388	387	386	385	384	383
382	381	380	379	378	377	376	375	374	373
372	371	370	369	368	367	366	365	364	363
362	361	360	359	358	357	356	355	354	353
352	351	350	349	348	347	346	345	344	343
342	341	340	339	338	337	336	335	334	333
332	331	330	329	328	327	326	325	324	323
322	321	320	319	318	317	316	315	314	313
312	311	310	309	308	307	306	305	304	303
302	301	300	299	298	297	296	295	294	293
292	291	290	289	288	287	286	285	284	283
282	281	280	279	278	277	276	275	274	273
272	271	270	269	268	267	266	265	264	263
262	261	260	259	258	257	256	255	254	253
252	251	250	249	248	247	246	245	244	243
242	241	240	239	238	237	236	235	234	233
232	231	230	229	228	227	226	225	224	223
222	221	220	219	218	217	216	215	214	213
212	211	210	209	208	207	206	205	204	203

Table 23-3 VBR Shaping (Using PCR, SCR and MBS) Values for DS3, E3, E1, and T1 (Cells Per Second) (continued)

202	201	200	199	198	197	196	195	194	193
192	191	190	189	188	187	186	185	184	183
182	181	180	179	178	177	176	175	174	173
172	171	170	169	168	167	166	165	164	163
162	161	160	159	158	157	156	155	154	153
152	151	150	149	148	147	146	145	144	143
142	141	140	139	138	137	136	135	134	133
132	131	130	129	128	127	126	125	124	123
122	121	120	119	118	117	116	115	114	113
112	111	110	109	108	107	106	105	104	103
102	101	100	99	98	97	96	95	94	93
92	91	90	89	88	87	86			

Table 23-4 shows the OC-3c rates for best-effort connections and VBR connections when shaped using PCR-only mode.

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

354017	348571	343290	338166	333193	328364	323673	319114	314682
310372	306177	302095	298120	294248	290476	286799	283214	279718
276306	272977	269728	266554	263455	260427	257467	254575	251746
248979	246273	243625	241033	238496	236012	233579	231195	228860
226571	224328	222129	219972	217857	215782	213747	211749	209788
207864	205974	204118	202296	200506	198747	197019	195320	193651
192010	190396	188810	187249	185714	184204	182719	181257	179819
178403	177009	175637	174286	172955	171645	170355	169083	167831
166597	165381	164182	163001	161837	160689	159557	158442	157341
156256	155186	154130	153089	152061	151048	150047	149060	148086
147124	146175	145238	144313	143400	142498	141607	140728	139859
139001	138153	137316	136489	135672	134864	134066	133277	132498
131728	130966	130214	129470	128734	128007	127288	126576	125873
125178	124490	123810	123137	122471	121813	121161	120517	119879
119248	118624	118006	117395	116790	116191	115598	115011	114430
113855	113286	112722	112164	111612	111065	110523	109986	109455
108929	108408	107891	107380	106874	106372	105875	105382	104894
104411	103932	103458	102987	102521	102059	101602	101148	100699
100253	99811	99374	98940	98510	98083	97660	97241	96826

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

96414	96005	95600	95198	94800	94405	94013	93625	93240
92857	92478	92102	91730	91360	90993	90629	90268	89910
89554	89202	88852	88505	88160	87819	87480	87143	86809
86478	86149	85823	85499	85178	84859	84542	84228	83916
83606	83299	82993	82691	82390	82091	81795	81501	81209
80919	80631	80345	80061	79779	79499	79221	78945	78671
78399	78128	77860	77593	77328	77065	76804	76545	76287
76031	75777	75524	75273	75024	74776	74530	74286	74043
73802	73562	73324	73088	72853	72619	72387	72157	71928
71700	71474	71249	71026	70804	70583	70364	70146	69930
69715	69501	69288	69077	68867	68658	68451	68245	68040
67836	67634	67432	67232	67033	66836	66639	66444	66249
66056	65864	65673	65483	65295	65107	64921	64735	64551
64367	64185	64004	63823	63644	63466	63288	63112	62937
62763	62589	62417	62245	62075	61905	61736	61569	61402
61236	61071	60907	60743	60581	60419	60259	60099	59940
59782	59624	59468	59312	59157	59003	58850	58698	58546
58395	58245	58096	57947	57799	57652	57506	57360	57215
57071	56928	56785	56643	56502	56361	56222	56082	55944
55806	55669	55533	55397	55262	55127	54993	54860	54728
54596	54465	54334	54204	54075	53946	53818	53690	53563
53437	53311	53186	53062	52938	52814	52691	52569	52447
52326	52206	52086	51966	51847	51729	51611	51494	51377
51261	51145	51030	50915	50801	50687	50574	50462	50350
50238	50127	50016	49906	49796	49687	49578	49470	49362
49255	49148	49042	48936	48830	48725	48621	48517	48413
48310	48207	48105	48003	47901	47800	47700	47599	47500
47400	47301	47203	47105	47007	46910	46813	46716	46620
46524	46429	46334	46239	46145	46051	45958	45865	45772
45680	45588	45497	45405	45315	45224	45134	45044	44955
44866	44777	44689	44601	44513	44426	44339	44253	44166
44080	43995	43910	43825	43740	43656	43572	43488	43405
43322	43239	43157	43075	42993	42912	42831	42750	42669
42589	42509	42430	42350	42271	42192	42114	42036	41958
41881	41803	41726	41650	41573	41497	41421	41346	41270
41195	41120	41046	40972	40898	40824	40751	40677	40605
40532	40460	40387	40316	40244	40173	40102	40031	39960

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

39890	39820	39750	39680	39611	39542	39473	39404	39336
39268	39200	39132	39064	38997	38930	38863	38797	38731
38664	38599	38533	38468	38402	38337	38273	38208	38144
38080	38016	37952	37889	37825	37762	37699	37637	37574
37512	37450	37388	37327	37265	37204	37143	37082	37022
36961	36901	36841	36781	36722	36662	36603	36544	36485
36427	36368	36310	36252	36194	36136	36079	36021	35964
35907	35850	35794	35737	35681	35625	35569	35513	35458
35402	35347	35292	35237	35182	35128	35073	35019	34965
34911	34858	34804	34751	34697	34644	34591	34539	34486
34434	34382	34329	34277	34226	34174	34123	34071	34020
33969	33918	33868	33817	33767	33716	33666	33616	33567
33517	33467	33418	33369	33320	33271	33222	33173	33125
33077	33028	32980	32932	32885	32837	32789	32742	32695
32648	32601	32554	32507	32461	32414	32368	32322	32276
32230	32184	32138	32093	32047	32002	31957	31912	31867
31822	31778	31733	31689	31644	31600	31556	31512	31469
31425	31382	31338	31295	31252	31209	31166	31123	31080
31038	30995	30953	30911	30868	30826	30785	30743	30701
30660	30618	30577	30536	30495	30454	30413	30372	30331
30291	30250	30210	30170	30130	30090	30050	30010	29970
29931	29891	29852	29812	29773	29734	29695	29656	29618
29579	29540	29502	29464	29425	29387	29349	29311	29273
29235	29198	29160	29123	29085	29048	29011	28974	28937
28900	28863	28826	28790	28753	28717	28680	28644	28608
28572	28536	28500	28464	28428	28393	28357	28322	28287
28251	28216	28181	28146	28111	28076	28041	28007	27972
27938	27903	27869	27835	27801	27767	27733	27699	27665
27631	27597	27564	27530	27497	27464	27430	27397	27364
27331	27298	27265	27233	27200	27167	27135	27102	27070
27038	27005	26973	26941	26909	26877	26845	26814	26782
26750	26719	26687	26656	26625	26593	26562	26531	26500
26469	26438	26407	26377	26346	26315	26285	26254	26224
26194	26163	26133	26103	26073	26043	26013	25983	25954
25924	25894	25865	25835	25806	25776	25747	25718	25689
25660	25631	25602	25573	25544	25515	25487	25458	25429
25401	25372	25344	25316	25287	25259	25231	25203	25175

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

25147	25119	25091	25064	25036	25008	24981	24953	24926
24898	24871	24844	24817	24789	24762	24735	24708	24681
24655	24628	24601	24574	24548	24521	24495	24468	24442
24415	24389	24363	24337	24311	24285	24259	24233	24207
24181	24155	24129	24104	24078	24053	24027	24002	23976
23951	23926	23900	23875	23850	23825	23800	23775	23750
23725	23700	23676	23651	23626	23602	23577	23553	23528
23504	23479	23455	23431	23407	23382	23358	23334	23310
23286	23262	23239	23215	23191	23167	23144	23120	23096
23073	23049	23026	23003	22979	22956	22933	22910	22886
22863	22840	22817	22794	22771	22749	22726	22703	22680
22658	22635	22612	22590	22567	22545	22522	22500	22478
22455	22433	22411	22389	22367	22345	22323	22301	22279
22257	22235	22213	22192	22170	22148	22127	22105	22083
22062	22040	22019	21998	21976	21955	21934	21913	21891
21870	21849	21828	21807	21786	21765	21744	21723	21703
21682	21661	21641	21620	21599	21579	21558	21538	21517
21497	21476	21456	21436	21416	21395	21375	21355	21335
21315	21295	21275	21255	21235	21215	21195	21175	21156
21136	21116	21096	21077	21057	21038	21018	20999	20979
20960	20941	20921	20902	20883	20863	20844	20825	20806
20787	20768	20749	20730	20711	20692	20673	20654	20635
20617	20598	20579	20560	20542	20523	20505	20486	20468
20449	20431	20412	20394	20376	20357	20339	20321	20303
20284	20266	20248	20230	20212	20194	20176	20158	20140
20122	20104	20087	20069	20051	20033	20016	19998	19980
19963	19945	19928	19910	19893	19875	19858	19840	19823
19806	19788	19771	19754	19737	19719	19702	19685	19668
19651	19634	19617	19600	19583	19566	19549	19532	19516
19499	19482	19465	19449	19432	19415	19399	19382	19366
19349	19332	19316	19300	19283	19267	19250	19234	19218
19201	19185	19169	19153	19137	19120	19104	19088	19072
19056	19040	19024	19008	18992	18976	18960	18945	18929
18913	18897	18881	18866	18850	18834	18819	18803	18787
18772	18756	18741	18725	18710	18694	18679	18664	18648
18633	18618	18602	18587	18572	18557	18541	18526	18511
18496	18481	18466	18451	18436	18421	18406	18391	18376

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

18361	18346	18331	18317	18302	18287	18272	18258	18243
18228	18214	18199	18184	18170	18155	18141	18126	18112
18097	18083	18068	18054	18040	18025	18011	17997	17982
17968	17954	17940	17925	17911	17897	17883	17869	17855
17841	17827	17813	17799	17785	17771	17757	17743	17729
17715	17701	17688	17674	17660	17646	17632	17619	17605
17591	17578	17564	17551	17537	17523	17510	17496	17483
17469	17456	17442	17429	17416	17402	17389	17376	17362
17349	17336	17322	17309	17296	17283	17270	17256	17243
17230	17217	17204	17191	17178	17165	17152	17139	17126
17113	17100	17087	17074	17062	17049	17036	17023	17010
16998	16985	16972	16959	16947	16934	16921	16909	16896
16884	16871	16858	16846	16833	16821	16808	16796	16784
16771	16759	16746	16734	16722	16709	16697	16685	16672
16660	16648	16636	16623	16611	16599	16587	16575	16563
16551	16539	16526	16514	16502	16490	16478	16466	16454
16443	16431	16419	16407	16395	16383	16371	16359	16348
16336	16324	16312	16301	16289	16277	16265	16254	16242
16231	16219	16207	16196	16184	16173	16161	16150	16138
16127	16115	16104	16092	16081	16069	16058	16047	16035
16024	16013	16001	15990	15979	15967	15956	15945	15934
15923	15911	15900	15889	15878	15867	15856	15845	15834
15822	15811	15800	15789	15778	15767	15756	15746	15735
15724	15713	15702	15691	15680	15669	15658	15648	15637
15626	15615	15605	15594	15583	15572	15562	15551	15540
15530	15519	15508	15498	15487	15477	15466	15456	15445
15434	15424	15413	15403	15393	15382	15372	15361	15351
15340	15330	15320	15309	15299	15289	15278	15268	15258
15248	15237	15227	15217	15207	15196	15186	15176	15166
15156	15146	15135	15125	15115	15105	15095	15085	15075
15065	15055	15045	15035	15025	15015	15005	14995	14985
14975	14966	14956	14946	14936	14926	14916	14906	14897
14887	14877	14867	14858	14848	14838	14828	14819	14809
14799	14790	14780	14770	14761	14751	14742	14732	14722
14713	14703	14694	14684	14675	14665	14656	14646	14637
14627	14618	14609	14599	14590	14580	14571	14562	14552
14543	14534	14524	14515	14506	14496	14487	14478	14469

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

14459	14450	14441	14432	14423	14413	14404	14395	14386
14377	14368	14359	14350	14340	14331	14322	14313	14304
14295	14286	14277	14268	14259	14250	14241	14232	14223
14214	14206	14197	14188	14179	14170	14161	14152	14144
14135	14126	14117	14108	14099	14091	14082	14073	14064
14056	14047	14038	14030	14021	14012	14004	13995	13986
13978	13969	13961	13952	13943	13935	13926	13918	13909
13901	13892	13884	13875	13867	13858	13850	13841	13833
13824	13816	13807	13799	13791	13782	13774	13765	13757
13749	13740	13732	13724	13715	13707	13699	13691	13682
13674	13666	13658	13649	13641	13633	13625	13617	13608
13600	13592	13584	13576	13568	13559	13551	13543	13535
13527	13519	13511	13503	13495	13487	13479	13471	13463
13455	13447	13439	13431	13423	13415	13407	13399	13391
13383	13375	13368	13360	13352	13344	13336	13328	13320
13313	13305	13297	13289	13281	13274	13266	13258	13250
13243	13235	13227	13219	13212	13204	13196	13189	13181
13173	13166	13158	13150	13143	13135	13127	13120	13112
13105	13097	13090	13082	13074	13067	13059	13052	13044
13037	13029	13022	13014	13007	12999	12992	12985	12977
12970	12962	12955	12947	12940	12933	12925	12918	12911
12903	12896	12888	12881	12874	12867	12859	12852	12845
12837	12830	12823	12816	12808	12801	12794	12787	12779
12772	12765	12758	12751	12744	12736	12729	12722	12715
12708	12701	12694	12686	12679	12672	12665	12658	12651
12644	12637	12630	12623	12616	12609	12602	12595	12588
12581	12574	12567	12560	12553	12546	12539	12532	12525
12518	12511	12504	12498	12491	12484	12477	12470	12463
12456	12449	12443	12436	12429	12422	12415	12409	12402
12395	12388	12381	12375	12368	12361	12354	12348	12341
12334	12328	12321	12314	12307	12301	12294	12287	12281
12274	12267	12261	12254	12248	12241	12234	12228	12221
12215	12208	12201	12195	12188	12182	12175	12169	12162
12156	12149	12143	12136	12130	12123	12117	12110	12104
12097	12091	12084	12078	12071	12065	12059	12052	12046
12039	12033	12027	12020	12014	12007	12001	11995	11988
11982	11976	11969	11963	11957	11950	11944	11938	11932

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

11925	11919	11913	11906	11900	11894	11888	11882	11875
11869	11863	11857	11850	11844	11838	11832	11826	11820
11813	11807	11801	11795	11789	11783	11777	11770	11764
11758	11752	11746	11740	11734	11728	11722	11716	11710
11704	11697	11691	11685	11679	11673	11667	11661	11655
11649	11643	11637	11631	11625	11620	11614	11608	11602
11596	11590	11584	11578	11572	11566	11560	11554	11548
11543	11537	11531	11525	11519	11513	11507	11502	11496
11490	11484	11478	11472	11467	11461	11455	11449	11443
11438	11432	11426	11420	11415	11409	11403	11397	11392
11386	11380	11375	11369	11363	11357	11352	11346	11340
11335	11329	11323	11318	11312	11306	11301	11295	11290
11284	11278	11273	11267	11261	11256	11250	11245	11239
11234	11228	11222	11217	11211	11206	11200	11195	11189
11184	11178	11173	11167	11162	11156	11151	11145	11140
11134	11129	11123	11118	11112	11107	11101	11096	11091
11085	11080	11074	11069	11064	11058	11053	11047	11042
11037	11031	11026	11020	11015	11010	11004	10999	10994
10988	10983	10978	10972	10967	10962	10957	10951	10946
10941	10935	10930	10925	10920	10914	10909	10904	10899
10893	10888	10883	10878	10872	10867	10862	10857	10852
10846	10841	10836	10831	10826	10821	10815	10810	10805
10800	10795	10790	10784	10779	10774	10769	10764	10759
10754	10749	10744	10738	10733	10728	10723	10718	10713
10708	10703	10698	10693	10688	10683	10678	10673	10668
10663	10658	10653	10648	10643	10638	10633	10628	10623
10618	10613	10608	10603	10598	10593	10588	10583	10578
10573	10568	10563	10558	10553	10548	10544	10539	10534
10529	10524	10519	10514	10509	10504	10500	10495	10490
10485	10480	10475	10471	10466	10461	10456	10451	10446
10442	10437	10432	10427	10422	10418	10413	10408	10403
10398	10394	10389	10384	10379	10375	10370	10365	10360
10356	10351	10346	10341	10337	10332	10327	10323	10318
10313	10309	10304	10299	10294	10290	10285	10280	10276
10271	10267	10262	10257	10253	10248	10243	10239	10234
10229	10225	10220	10216	10211	10206	10202	10197	10193
10188	10183	10179	10174	10170	10165	10161	10156	10152

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

10147	10142	10138	10133	10129	10124	10120	10115	10111
10106	10102	10097	10093	10088	10084	10079	10075	10070
10066	10061	10057	10052	10048	10044	10039	10035	10030
10026	10021	10017	10012	10008	10004	9999	9995	9990
9986	9982	9977	9973	9968	9964	9960	9955	9951
9947	9942	9938	9933	9929	9925	9920	9916	9912
9907	9903	9899	9894	9890	9886	9881	9877	9873
9869	9864	9860	9856	9851	9847	9843	9839	9834
9830	9826	9822	9817	9813	9809	9805	9800	9796
9792	9788	9783	9779	9775	9771	9766	9762	9758
9754	9750	9745	9741	9737	9733	9729	9725	9720
9716	9712	9708	9704	9700	9695	9691	9687	9683
9679	9675	9671	9666	9662	9658	9654	9650	9646
9642	9638	9634	9630	9625	9621	9617	9613	9609
9605	9601	9597	9593	9589	9585	9581	9577	9573
9569	9564	9560	9556	9552	9548	9544	9540	9536
9532	9528	9524	9520	9516	9512	9508	9504	9500
9496	9492	9488	9484	9480	9476	9473	9469	9465
9461	9457	9453	9449	9445	9441	9437	9433	9429
9425	9421	9417	9413	9410	9406	9402	9398	9394
9390	9386	9382	9378	9375	9371	9367	9363	9359
9355	9351	9347	9344	9340	9336	9332	9328	9324
9321	9317	9313	9309	9305	9301	9298	9294	9290
9286	9282	9279	9275	9271	9267	9263	9260	9256
9252	9248	9245	9241	9237	9233	9229	9226	9222
9218	9214	9211	9207	9203	9199	9196	9192	9188
9185	9181	9177	9173	9170	9166	9162	9159	9155
9151	9147	9144	9140	9136	9133	9129	9125	9122
9118	9114	9111	9107	9103	9100	9096	9092	9089
9085	9081	9078	9074	9071	9067	9063	9060	9056
9052	9049	9045	9042	9038	9034	9031	9027	9024
9020	9016	9013	9009	9006	9002	8999	8995	8991
8988	8984	8981	8977	8974	8970	8967	8963	8959
8956	8952	8949	8945	8942	8938	8935	8931	8928
8924	8921	8917	8914	8910	8907	8903	8900	8896
8893	8889	8886	8882	8879	8875	8872	8868	8865
8861	8858	8854	8851	8847	8844	8841	8837	8834

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

8830	8827	8823	8820	8816	8813	8810	8806	8803
8799	8796	8793	8789	8786	8782	8779	8776	8772
8769	8765	8762	8759	8755	8752	8748	8745	8742
8738	8735	8732	8728	8725	8721	8718	8715	8711
8708	8705	8701	8698	8695	8691	8688	8685	8681
8678	8675	8671	8668	8665	8661	8658	8655	8652
8648	8645	8642	8638	8635	8632	8628	8625	8622
8619	8615	8612	8609	8606	8602	8599	8596	8592
8589	8586	8583	8579	8576	8573	8570	8567	8563
8560	8557	8554	8550	8547	8544	8541	8537	8534
8531	8528	8525	8521	8518	8515	8512	8509	8505
8502	8499	8496	8493	8489	8486	8483	8480	8477
8474	8470	8467	8464	8461	8458	8455	8451	8448
8445	8442	8439	8436	8433	8429	8426	8423	8420
8417	8414	8411	8408	8404	8401	8398	8395	8392
8389	8386	8383	8380	8377	8373	8370	8367	8364
8361	8358	8355	8352	8349	8346	8343	8340	8336
8333	8330	8327	8324	8321	8318	8315	8312	8309
8306	8303	8300	8297	8294	8291	8288	8285	8282
8279	8276	8273	8270	8266	8263	8260	8257	8254
8251	8248	8245	8242	8239	8236	8233	8230	8227
8224	8222	8219	8216	8213	8210	8207	8204	8201
8198	8195	8192	8189	8186	8183	8180	8177	8174
8171	8168	8165	8162	8159	8156	8153	8151	8148
8145	8142	8139	8136	8133	8130	8127	8124	8121
8118	8116	8113	8110	8107	8104	8101	8098	8095
8092	8089	8087	8084	8081	8078	8075	8072	8069
8066	8064	8061	8058	8055	8052	8049	8046	8043
8041	8038	8035	8032	8029	8026	8024	8021	8018
8015	8012	8009	8007	8004	8001	7998	7995	7992
7990	7987	7984	7981	7978	7976	7973	7970	7967
7964	7962	7959	7956	7953	7950	7948	7945	7942
7939	7936	7934	7931	7928	7925	7923	7920	7917
7914	7911	7909	7906	7903	7900	7898	7895	7892
7889	7887	7884	7881	7878	7876	7873	7870	7868
7865	7862	7859	7857	7854	7851	7848	7846	7843
7840	7838	7835	7832	7829	7827	7824	7821	7819

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

7816	7813	7811	7808	7805	7803	7800	7797	7794
7792	7789	7786	7784	7781	7778	7776	7773	7770
7768	7765	7762	7760	7757	7754	7752	7749	7747
7744	7741	7739	7736	7733	7731	7728	7725	7723
7720	7717	7715	7712	7710	7707	7704	7702	7699
7697	7694	7691	7689	7686	7683	7681	7678	7676
7673	7670	7668	7665	7663	7660	7658	7655	7652
7650	7647	7645	7642	7639	7637	7634	7632	7629
7627	7624	7621	7619	7616	7614	7611	7609	7606
7604	7601	7598	7596	7593	7591	7588	7586	7583
7581	7578	7576	7573	7571	7568	7565	7563	7560
7558	7555	7553	7550	7548	7545	7543	7540	7538
7535	7533	7530	7528	7525	7523	7520	7518	7515
7513	7510	7508	7505	7503	7500	7498	7495	7493
7490	7488	7485	7483	7481	7478	7476	7473	7471
7468	7466	7463	7461	7458	7456	7453	7451	7449
7446	7444	7441	7439	7436	7434	7431	7429	7427
7424	7422	7419	7417	7414	7412	7410	7407	7405
7402	7400	7398	7395	7393	7390	7388	7385	7383
7381	7378	7376	7373	7371	7369	7366	7364	7361
7359	7357	7354	7352	7350	7347	7345	7342	7340
7338	7335	7333	7331	7328	7326	7323	7321	7319
7316	7314	7312	7309	7307	7305	7302	7300	7297
7295	7293	7290	7288	7286	7283	7281	7279	7276
7274	7272	7269	7267	7265	7262	7260	7258	7255
7253	7251	7248	7246	7244	7241	7239	7237	7235
7232	7230	7228	7225	7223	7221	7218	7216	7214
7212	7209	7207	7205	7202	7200	7198	7196	7193
7191	7189	7186	7184	7182	7180	7177	7175	7173
7170	7168	7166	7164	7161	7159	7157	7155	7152
7150	7148	7146	7143	7141	7139	7137	7134	7132
7130	7128	7125	7123	7121	7119	7116	7114	7112
7110	7107	7105	7103	7101	7099	7096	7094	7092
7090	7087	7085	7083	7081	7079	7076	7074	7072
7070	7068	7065	7063	7061	7059	7057	7054	7052
7050	7048	7046	7043	7041	7039	7037	7035	7032
7030	7028	7026	7024	7022	7019	7017	7015	7013

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

7011	7009	7006	7004	7002	7000	6998	6996	6993
6991	6989	6987	6985	6983	6981	6978	6976	6974
6972	6970	6968	6965	6963	6961	6959	6957	6955
6953	6951	6948	6946	6944	6942	6940	6938	6936
6934	6931	6929	6927	6925	6923	6921	6919	6917
6914	6912	6910	6908	6906	6904	6902	6900	6898
6896	6893	6891	6889	6887	6885	6883	6881	6879
6877	6875	6873	6870	6868	6866	6864	6862	6860
6858	6856	6854	6852	6850	6848	6846	6843	6841
6839	6837	6835	6833	6831	6829	6827	6825	6823
6821	6819	6817	6815	6813	6811	6809	6806	6804
6802	6800	6798	6796	6794	6792	6790	6788	6786
6784	6782	6780	6778	6776	6774	6772	6770	6768
6766	6764	6762	6760	6758	6756	6754	6752	6750
6748	6746	6744	6742	6740	6738	6736	6734	6732
6730	6728	6726	6724	6722	6720	6718	6716	6714
6712	6710	6708	6706	6704	6702	6700	6698	6696
6694	6692	6690	6688	6686	6684	6682	6680	6678
6676	6674	6672	6670	6668	6666	6664	6662	6660
6658	6657	6655	6653	6651	6649	6647	6645	6643
6641	6639	6637	6635	6633	6631	6629	6627	6625
6623	6622	6620	6618	6616	6614	6612	6610	6608
6606	6604	6602	6600	6598	6596	6595	6593	6591
6589	6587	6585	6583	6581	6579	6577	6575	6573
6572	6570	6568	6566	6564	6562	6560	6558	6556
6554	6553	6551	6549	6547	6545	6543	6541	6539
6537	6536	6534	6532	6530	6528	6526	6524	6522
6521	6519	6517	6515	6513	6511	6509	6507	6506
6504	6502	6500	6498	6496	6494	6493	6491	6489
6487	6485	6483	6481	6480	6478	6476	6474	6472
6470	6468	6467	6465	6463	6461	6459	6457	6456
6454	6452	6450	6448	6446	6444	6443	6441	6439
6437	6435	6434	6432	6430	6428	6426	6424	6423
6421	6419	6417	6415	6413	6412	6410	6408	6406
6404	6403	6401	6399	6397	6395	6394	6392	6390
6388	6386	6385	6383	6381	6379	6377	6376	6374
6372	6370	6368	6367	6365	6363	6361	6359	6358

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

6356	6354	6352	6351	6349	6347	6345	6343	6342
6340	6338	6336	6335	6333	6331	6329	6328	6326
6324	6322	6320	6319	6317	6315	6313	6312	6310
6308	6306	6305	6303	6301	6299	6298	6296	6294
6292	6291	6289	6287	6285	6284	6282	6280	6278
6277	6275	6273	6271	6270	6268	6266	6265	6263
6261	6259	6258	6256	6254	6252	6251	6249	6247
6246	6244	6242	6240	6239	6237	6235	6234	6232
6230	6228	6227	6225	6223	6222	6220	6218	6216
6215	6213	6211	6210	6208	6206	6205	6203	6201
6199	6198	6196	6194	6193	6191	6189	6188	6186
6184	6183	6181	6179	6177	6176	6174	6172	6171
6169	6167	6166	6164	6162	6161	6159	6157	6156
6154	6152	6151	6149	6147	6146	6144	6142	6141
6139	6137	6136	6134	6132	6131	6129	6127	6126
6124	6122	6121	6119	6117	6116	6114	6112	6111
6109	6108	6106	6104	6103	6101	6099	6098	6096
6094	6093	6091	6089	6088	6086	6085	6083	6081
6080	6078	6076	6075	6073	6072	6070	6068	6067
6065	6063	6062	6060	6059	6057	6055	6054	6052
6050	6049	6047	6046	6044	6042	6041	6039	6038
6036	6034	6033	6031	6030	6028	6026	6025	6023
6022	6020	6018	6017	6015	6014	6012	6010	6009
6007	6006	6004	6002	6001	5999	5998	5996	5994
5993	5991	5990	5988	5987	5985	5983	5982	5980
5979	5977	5975	5974	5972	5971	5969	5968	5966
5964	5963	5961	5960	5958	5957	5955	5953	5952
5950	5949	5947	5946	5944	5943	5941	5939	5938
5936	5935	5933	5932	5930	5929	5927	5925	5924
5922	5921	5919	5918	5916	5915	5913	5912	5910
5908	5907	5905	5904	5902	5901	5899	5898	5896
5895	5893	5892	5890	5889	5887	5885	5884	5882
5881	5879	5878	5876	5875	5873	5872	5870	5869
5867	5866	5864	5863	5861	5860	5858	5857	5855
5854	5852	5851	5849	5847	5846	5844	5843	5841
5840	5838	5837	5835	5834	5832	5831	5829	5828
5826	5825	5823	5822	5820	5819	5817	5816	5814

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

5813	5811	5810	5809	5807	5806	5804	5803	5801
5800	5798	5797	5795	5794	5792	5791	5789	5788
5786	5785	5783	5782	5780	5779	5777	5776	5774
5773	5772	5770	5769	5767	5766	5764	5763	5761
5760	5758	5757	5755	5754	5752	5751	5750	5748
5747	5745	5744	5742	5741	5739	5738	5736	5735
5734	5732	5731	5729	5728	5726	5725	5723	5722
5721	5719	5718	5716	5715	5713	5712	5710	5709
5708	5706	5705	5703	5702	5700	5699	5698	5696
5695	5693	5692	5690	5689	5688	5686	5685	5683
5682	5680	5679	5678	5676	5675	5673	5672	5670
5669	5668	5666	5665	5663	5662	5661	5659	5658
5656	5655	5653	5652	5651	5649	5648	5646	5645
5644	5642	5641	5639	5638	5637	5635	5634	5632
5631	5630	5628	5627	5625	5624	5623	5621	5620
5618	5617	5616	5614	5613	5611	5610	5609	5607
5606	5605	5603	5602	5600	5599	5598	5596	5595
5593	5592	5591	5589	5588	5587	5585	5584	5582
5581	5580	5578	5577	5576	5574	5573	5571	5570
5569	5567	5566	5565	5563	5562	5561	5559	5558
5556	5555	5554	5552	5551	5550	5548	5547	5546
5544	5543	5541	5540	5539	5537	5536	5535	5533
5532	5447	5364	5284	5207	5131	5058	4987	4917
4850	4785	4721	4659	4598	4539	4482	4426	4371
4318	4266	4215	4165	4117	4070	4023	3978	3934
3891	3849	3807	3767	3727	3688	3650	3613	3576
3541	3506	3471	3438	3405	3372	3340	3309	3278
3248	3219	3190	3161	3133	3106	3079	3052	3026
3001	2975	2951	2926	2902	2879	2855	2833	2810
2788	2766	2745	2724	2703	2682	2662	2642	2623
2604	2585	2566	2547	2529	2511	2494	2476	2459
2442	2425	2409	2393	2376	2361	2345	2330	2314
2299	2284	2270	2255	2241	2227	2213	2199	2186
2172	2159	2146	2133	2120	2108	2095	2083	2071
2059	2047	2035	2023	2012	2001	1989	1978	1967
1956	1946	1935	1925	1914	1904	1894	1884	1874
1864	1854	1844	1835	1825	1816	1807	1798	1788

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

1779	1771	1762	1753	1744	1736	1727	1719	1711
1703	1694	1686	1678	1670	1663	1655	1647	1639
1632	1624	1617	1610	1602	1595	1588	1581	1574
1567	1560	1553	1546	1540	1533	1526	1520	1513
1507	1501	1494	1488	1482	1476	1469	1463	1457
1451	1445	1440	1434	1428	1422	1417	1411	1405
1400	1394	1389	1383	1378	1373	1367	1362	1357
1352	1347	1341	1336	1331	1326	1321	1317	1312
1307	1302	1297	1293	1288	1283	1279	1274	1269
1265	1260	1256	1251	1247	1243	1238	1234	1230
1225	1221	1217	1213	1209	1205	1201	1197	1192
1188	1185	1181	1177	1173	1169	1165	1161	1157
1154	1150	1146	1142	1139	1135	1132	1128	1124
1121	1117	1114	1110	1107	1103	1100	1097	1093
1090	1086	1083	1080	1077	1073	1070	1067	1064
1060	1057	1054	1051	1048	1045	1042	1039	1036
1033	1030	1027	1024	1021	1018	1015	1012	1009
1006	1003	1001	998	995	992	989	987	984
981	978	976	973	970	968	965	963	960
957	955	952	950	947	945	942	940	937
935	932	930	927	925	922	920	918	915
913	911	908	906	904	901	899	897	894
892	890	888	886	883	881	879	877	875
872	870	868	866	864	862	860	858	856
854	852	849	847	845	843	841	839	837
835	833	832	830	828	826	824	822	820
818	816	814	812	811	809	807	805	803
801	800	798	796	794	792	791	789	787
785	784	782	780	779	777	775	773	772
770	768	767	765	763	762	760	759	757
755	754	752	751	749	747	746	744	743
741	740	738	737	735	733	732	730	729
727	726	724	723	722	720	719	717	716
714	713	711	710	709	707	706	704	703
702	700	699	697	696	695	693	692	691
689	688	687	685	684	683	681	680	679
677	676	675	674	672	671	670	668	667

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

666	665	663	662	661	660	659	657	656
655	654	652	651	650	649	648	647	645
644	643	642	641	640	638	637	636	635
634	633	632	630	629	628	627	626	625
624	623	622	620	619	618	617	616	615
614	613	612	611	610	609	608	607	606
605	604	603	602	601	600	599	597	596
595	594	593	592	591	590	589	588	587
586	585	584	583	582	581	580	579	578
577	576	575	574	573	572	571	570	569
568	567	566	565	564	563	562	561	560
559	558	557	556	555	554	553	552	551
550	549	548	547	546	545	544	543	542
541	540	539	538	537	536	535	534	533
532	531	530	529	528	527	526	525	524
523	522	521	520	519	518	517	516	515
514	513	512	511	510	509	508	507	506
505	504	503	502	501	500	499	498	497
496	495	494	493	492	491	490	489	488
487	486	485	484	483	482	481	480	479
478	477	476	475	474	473	472	471	470
469	468	467	466	465	464	463	462	461
460	459	458	457	456	455	454	453	452
451	450	449	448	447	446	445	444	443
442	441	440	439	438	437	436	435	434
433	432	431	430	429	428	427	426	425
424	423	422	421	420	419	418	417	416
415	414	413	412	411	410	409	408	407
406	405	404	403	402	401	400	399	398
397	396	395	394	393	392	391	390	389
388	387	386	385	384	383	382	381	380
379	378	377	376	375	374	373	372	371
370	369	368	367	366	365	364	363	362
361	360	359	358	357	356	355	354	353
352	351	350	349	348	347	346	345	344
343	342	341	340	339	338	337	336	335
334	333	332	331	330	329	328	327	326

Table 23-4 Best-Effort and VBR Shaping (Pcr-Only Mode) Rates for OC-3c (Cells Per Second)

325	324	323	322	321	320	319	318	317
316	315	314	313	312	311	310	309	308
307	306	305	304	303	302	301	300	299
298	297	296	295	294	293	292	291	290
289	288	287	286	285	284	283	282	281
280	279	278	277	276	275	274	273	272
271	270	269	268	267	266	265	264	263
262	261	260	259	258	257	256	255	254
253	252	251	250	249	248	247	246	245
244	243	242	241	240	239	238	237	236
235	234	233	232	231	230	229	228	227
226	225	224	223	222	221	220	219	218
217	216	215	214	213	212	211	210	209
208	207	206	205	204	203	202	201	200
199	198	197	196	195	194	193	192	191
190	189	188	187	186	185	184	183	182
181	180	179	178	177	176	175	174	173
172	171	170	169	168	167	166	165	164
163	162	161	160	159	158	157	156	155
154	153	152	151	150	149	148	147	146
145	144	143	142	141	140	139	138	137
136	135	134	133	132	131	130	129	128
127	126	125	124	123	122	121	120	119
118	117	116	115	114	113	112	111	110
109	108	107	106	105	104	103	102	101
100	99	98	97	96	95	94	93	92
91	90	89	88	87				

Table 23-5 shows the DS3, E3, E1 and T1 rates for VBR connections that are shaped using their PCR, SCR and MBS parameters (the default shaping mode).

Table 23-5 VBR Shaping (Using PCR, SCR and MBS) Rates for OC-3c (Cells Per Second)

354017	177009	118006	88505	70804	59003	50574	44253	39336	35402
32184	29502	27233	25287	23602	22127	20825	19668	18633	17701
16858	16092	15393	14751	14161	13617	13112	12644	12208	11801
11420	11064	10728	10413	10115	9834	9569	9317	9078	8851
8635	8429	8233	8046	7868	7697	7533	7376	7225	7081

Table 23-5 VBR Shaping (Using PCR, SCR and MBS) Rates for OC-3c (Cells Per Second) (continued)

6942	6809	6680	6556	6437	6322	6211	6104	6001	5901
5804	5710	5620	5532	5447	5364	5284	5207	5131	5058
4987	4917	4850	4785	4721	4659	4598	4539	4482	4426
4371	4318	4266	4215	4165	4117	4070	4023	3978	3934
3891	3849	3807	3767	3727	3688	3650	3613	3576	3541
3506	3471	3438	3405	3372	3340	3309	3278	3248	3219
3190	3161	3133	3106	3079	3052	3026	3001	2975	2951
2926	2902	2879	2855	2833	2810	2788	2766	2745	2724
2703	2682	2662	2642	2623	2604	2585	2566	2547	2529
2511	2494	2476	2459	2442	2425	2409	2393	2376	2361
2345	2330	2314	2299	2284	2270	2255	2241	2227	2213
2199	2186	2172	2159	2146	2133	2120	2108	2095	2083
2071	2059	2047	2035	2023	2012	2001	1989	1978	1967
1956	1946	1935	1925	1914	1904	1894	1884	1874	1864
1854	1844	1835	1825	1816	1807	1798	1788	1779	1771
1762	1753	1744	1736	1727	1719	1711	1703	1694	1686
1678	1670	1663	1655	1647	1639	1632	1624	1617	1610
1602	1595	1588	1581	1574	1567	1560	1553	1546	1540
1533	1526	1520	1513	1507	1501	1494	1488	1482	1476
1469	1463	1457	1451	1445	1440	1434	1428	1422	1417
1411	1405	1400	1394	1389	1383	1378	1373	1367	1362
1357	1352	1347	1341	1336	1331	1326	1321	1317	1312
1307	1302	1297	1293	1288	1283	1279	1274	1269	1265
1260	1256	1251	1247	1243	1238	1234	1230	1225	1221
1217	1213	1209	1205	1201	1197	1192	1188	1185	1181
1177	1173	1169	1165	1161	1157	1154	1150	1146	1142
1139	1135	1132	1128	1124	1121	1117	1114	1110	1107
1103	1100	1097	1093	1090	1086	1083	1080	1077	1073
1070	1067	1064	1060	1057	1054	1051	1048	1045	1042
1039	1036	1033	1030	1027	1024	1021	1018	1015	1012
1009	1006	1003	1001	998	995	992	989	987	984
981	978	976	973	970	968	965	963	960	957
955	952	950	947	945	942	940	937	935	932
930	927	925	922	920	918	915	913	911	908
906	904	901	899	897	894	892	890	888	886
883	881	879	877	875	872	870	868	866	864
862	860	858	856	854	852	849	847	845	843

Table 23-5 VBR Shaping (Using PCR, SCR and MBS) Rates for OC-3c (Cells Per Second) (continued)

841	839	837	835	833	832	830	828	826	824
822	820	818	816	814	812	811	809	807	805
803	801	800	798	796	794	792	791	789	787
785	784	782	780	779	777	775	773	772	770
768	767	765	763	762	760	759	757	755	754
752	751	749	747	746	744	743	741	740	738
737	735	733	732	730	729	727	726	724	723
722	720	719	717	716	714	713	711	710	709
707	706	704	703	702	700	699	697	696	695
693	692	691	689	688	687	685	684	683	681
680	679	677	676	675	674	672	671	670	668
667	666	665	663	662	661	660	659	657	656
655	654	652	651	650	649	648	647	645	644
643	642	641	640	638	637	636	635	634	633
632	630	629	628	627	626	625	624	623	622
620	619	618	617	616	615	614	613	612	611
610	609	608	607	606	605	604	603	602	601
600	599	597	596	595	594	593	592	591	590
589	588	587	586	585	584	583	582	581	580
579	578	577	576	575	574	573	572	571	570
569	568	567	566	565	564	563	562	561	560
559	558	557	556	555	554	553	552	551	550
549	548	547	546	545	544	543	542	541	540
539	538	537	536	535	534	533	532	531	530
529	528	527	526	525	524	523	522	521	520
519	518	517	516	515	514	513	512	511	510
509	508	507	506	505	504	503	502	501	500
499	498	497	496	495	494	493	492	491	490
489	488	487	486	485	484	483	482	481	480
479	478	477	476	475	474	473	472	471	470
469	468	467	466	465	464	463	462	461	460
459	458	457	456	455	454	453	452	451	450
449	448	447	446	445	444	443	442	441	440
439	438	437	436	435	434	433	432	431	430
429	428	427	426	425	424	423	422	421	420
419	418	417	416	415	414	413	412	411	410
409	408	407	406	405	404	403	402	401	400

Table 23-5 VBR Shaping (Using PCR, SCR and MBS) Rates for OC-3c (Cells Per Second) (continued)

399	398	397	396	395	394	393	392	391	390
389	388	387	386	385	384	383	382	381	380
379	378	377	376	375	374	373	372	371	370
369	368	367	366	365	364	363	362	361	360
359	358	357	356	355	354	353	352	351	350
349	348	347	346	345	344	343	342	341	340
339	338	337	336	335	334	333	332	331	330
329	328	327	326	325	324	323	322	321	320
319	318	317	316	315	314	313	312	311	310
309	308	307	306	305	304	303	302	301	300
299	298	297	296	295	294	293	292	291	290
289	288	287	286	285	284	283	282	281	280
279	278	277	276	275	274	273	272	271	270
269	268	267	266	265	264	263	262	261	260
259	258	257	256	255	254	253	252	251	250
249	248	247	246	245	244	243	242	241	240
239	238	237	236	235	234	233	232	231	230
229	228	227	226	225	224	223	222	221	220
219	218	217	216	215	214	213	212	211	210
209	208	207	206	205	204	203	202	201	200
199	198	197	196	195	194	193	192	191	190
189	188	187	186	185	184	183	182	181	180
179	178	177	176	175	174	173	172	171	170
169	168	167	166	165	164	163	162	161	160
159	158	157	156	155	154	153	152	151	150
149	148	147	146	145	144	143	142	141	140
139	138	137	136	135	134	133	132	131	130
129	128	127	126	125	124	123	122	121	120
119	118	117	116	115	114	113	112	111	110
109	108	107	106	105	104	103	102	101	100
99	98	97	96	95	94	93	92	91	90
89	88	87							

Table 23-6 shows the OC-12 rates for best-effort connections and VBR connections when shaped using PCR-only mode.

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

1403649	1382055	1361115	1340800	1321082	1301936	1283337	1265262	1247688
1230597	1213967	1197781	1182021	1166670	1151712	1137134	1122920	1109056
1095531	1082332	1069447	1056866	1044576	1032570	1020836	1009366	998151
987182	976452	965952	955676	945617	935766	926119	916669	907410
898336	889441	880721	872171	863784	855558	847487	839566	831792
824161	816669	809312	802086	794988	788014	781162	774428	767808
761302	754904	748613	742426	736341	730354	724464	718669	712965
707351	701825	696384	691028	685753	680558	675441	670400	665434
660541	655720	650968	646285	641669	637118	632631	628207	623844
619542	615299	611113	606984	602910	598891	594925	591011	587148
583335	579572	575856	572189	568567	564991	561460	557973	554528
551126	547766	544446	541166	537926	534724	531560	528433	525343
522288	519269	516285	513335	510418	507535	504683	501864	499076
496318	493591	490894	488226	485587	482976	480394	477838	475310
472809	470333	467883	465459	463060	460685	458335	456008	453705
451425	449168	446934	444721	442530	440361	438213	436086	433979
431892	429826	427779	425752	423744	421754	419783	417831	415896
413980	412081	410199	408335	406487	404656	402841	401043	399261
397494	395743	394007	392287	390581	388890	387214	385552	383904
382271	380651	379045	377452	375873	374307	372754	371213	369686
368171	366668	365177	363699	362232	360778	359335	357903	356483
355074	353676	352289	350913	349547	348192	346848	345514	344190
342877	341573	340279	338995	337721	336456	335200	333954	332717
331490	330271	329061	327860	326668	325484	324309	323143	321984
320835	319693	318559	317433	316316	315206	314104	313009	311922
310843	309771	308707	307650	306600	305557	304521	303492	302470
301455	300447	299446	298451	297463	296481	295506	294537	293574
292618	291668	290724	289786	288854	287928	287009	286095	285186
284284	283387	282496	281610	280730	279856	278987	278123	277264
276411	275563	274721	273883	273051	272223	271401	270583	269771
268963	268160	267362	266569	265780	264996	264217	263442	262672
261906	261144	260388	259635	258887	258143	257403	256668	255936
255209	254486	253768	253053	252342	251635	250932	250233	249538
248847	248159	247476	246796	246120	245447	244779	244113	243452
242794	242139	241488	240841	240197	239557	238919	238286	237655
237028	236405	235784	235167	234553	233942	233334	232730	232128

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

231530	230935	230343	229754	229168	228585	228004	227427	226853
226281	225713	225147	224584	224024	223467	222912	222361	221812
221265	220722	220181	219642	219107	218574	218043	217515	216990
216467	215946	215429	214913	214400	213890	213382	212876	212373
211872	211374	210877	210383	209892	209403	208916	208431	207948
207468	206990	206514	206041	205569	205100	204633	204168	203705
203244	202785	202328	201874	201421	200970	200522	200075	199631
199188	198747	198309	197872	197437	197004	196573	196144	195716
195291	194867	194445	194025	193607	193191	192776	192364	191952
191543	191136	190730	190326	189923	189523	189124	188726	188331
187937	187544	187154	186765	186377	185991	185607	185224	184843
184464	184086	183709	183334	182961	182589	182219	181850	181482
181116	180752	180389	180028	179668	179309	178952	178596	178242
177889	177537	177187	176838	176491	176145	175800	175457	175115
174774	174435	174096	173760	173424	173090	172757	172426	172095
171766	171439	171112	170787	170463	170140	169818	169498	169179
168861	168544	168228	167914	167600	167288	166977	166668	166359
166051	165745	165440	165136	164833	164531	164230	163930	163632
163334	163038	162742	162448	162155	161863	161572	161282	160992
160704	160418	160132	159847	159563	159280	158998	158717	158437
158158	157880	157603	157327	157052	156778	156505	156233	155961
155691	155422	155153	154886	154619	154354	154089	153825	153562
153300	153039	152779	152519	152261	152003	151746	151490	151235
150981	150728	150475	150224	149973	149723	149474	149226	148978
148732	148486	148241	147996	147753	147510	147269	147028	146787
146548	146309	146071	145834	145598	145362	145127	144893	144660
144427	144196	143964	143734	143505	143276	143048	142820	142593
142367	142142	141918	141694	141471	141248	141026	140805	140585
140365	140146	139928	139711	139494	139277	139062	138847	138632
138419	138206	137994	137782	137571	137361	137151	136942	136733
136526	136318	136112	135906	135701	135496	135292	135089	134886
134683	134482	134281	134080	133881	133681	133483	133285	133087
132890	132694	132498	132303	132109	131915	131721	131528	131336
131144	130953	130763	130572	130383	130194	130006	129818	129630
129444	129257	129072	128886	128702	128518	128334	128151	127968
127786	127605	127424	127243	127063	126884	126705	126527	126349
126171	125994	125818	125642	125466	125291	125117	124943	124769

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

124596	124424	124252	124080	123909	123738	123568	123398	123229
123060	122892	122724	122556	122390	122223	122057	121891	121726
121561	121397	121233	121070	120907	120744	120582	120421	120260
120099	119938	119779	119619	119460	119301	119143	118985	118828
118671	118514	118358	118203	118047	117892	117738	117584	117430
117277	117124	116971	116819	116667	116516	116365	116215	116064
115915	115765	115616	115468	115320	115172	115024	114877	114730
114584	114438	114293	114147	114002	113858	113714	113570	113427
113284	113141	112999	112857	112715	112574	112433	112292	112152
112012	111873	111734	111595	111456	111318	111181	111043	110906
110769	110633	110497	110361	110226	110091	109956	109821	109687
109554	109420	109287	109154	109022	108890	108758	108626	108495
108364	108234	108103	107973	107844	107715	107586	107457	107328
107200	107073	106945	106818	106691	106565	106438	106312	106187
106061	105936	105811	105687	105563	105439	105315	105192	105069
104946	104824	104702	104580	104458	104337	104216	104095	103974
103854	103734	103615	103495	103376	103257	103139	103021	102903
102785	102667	102550	102433	102317	102200	102084	101968	101853
101737	101622	101507	101393	101278	101164	101051	100937	100824
100711	100598	100485	100373	100261	100149	100038	99927	99816
99705	99594	99484	99374	99264	99155	99045	98936	98827
98719	98610	98502	98394	98287	98179	98072	97965	97858
97752	97646	97540	97434	97328	97223	97118	97013	96908
96804	96700	96596	96492	96388	96285	96182	96079	95976
95874	95772	95670	95568	95467	95365	95264	95163	95062
94962	94862	94762	94662	94562	94463	94363	94264	94166
94067	93969	93870	93772	93675	93577	93480	93383	93286
93189	93092	92996	92900	92804	92708	92612	92517	92422
92327	92232	92137	92043	91949	91855	91761	91667	91574
91481	91388	91295	91202	91110	91017	90925	90833	90741
90650	90558	90467	90376	90285	90195	90104	90014	89924
89834	89744	89655	89565	89476	89387	89298	89210	89121
89033	88945	88857	88769	88681	88594	88506	88419	88332
88246	88159	88073	87986	87900	87814	87729	87643	87558
87472	87387	87302	87218	87133	87048	86964	86880	86796
86712	86629	86545	86462	86379	86296	86213	86130	86048
85966	85883	85801	85720	85638	85556	85475	85394	85312

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

85232	85151	85070	84990	84909	84829	84749	84669	84590
84510	84431	84351	84272	84193	84114	84036	83957	83879
83800	83722	83644	83567	83489	83411	83334	83257	83180
83103	83026	82949	82873	82796	82720	82644	82568	82492
82417	82341	82266	82190	82115	82040	81965	81891	81816
81742	81667	81593	81519	81445	81371	81298	81224	81151
81078	81005	80932	80859	80786	80713	80641	80569	80496
80424	80352	80281	80209	80137	80066	79995	79924	79853
79782	79711	79640	79570	79499	79429	79359	79289	79219
79149	79079	79010	78940	78871	78802	78733	78664	78595
78526	78458	78389	78321	78253	78185	78117	78049	77981
77913	77846	77778	77711	77644	77577	77510	77443	77376
77310	77243	77177	77111	77045	76979	76913	76847	76781
76716	76650	76585	76520	76455	76390	76325	76260	76195
76131	76066	76002	75938	75873	75809	75745	75682	75618
75554	75491	75427	75364	75301	75238	75175	75112	75049
74987	74924	74862	74799	74737	74675	74613	74551	74489
74428	74366	74304	74243	74182	74121	74059	73998	73938
73877	73816	73755	73695	73635	73574	73514	73454	73394
73334	73274	73214	73155	73095	73036	72977	72917	72858
72799	72740	72681	72623	72564	72505	72447	72389	72330
72272	72214	72156	72098	72040	71982	71925	71867	71810
71753	71695	71638	71581	71524	71467	71410	71354	71297
71240	71184	71128	71071	71015	70959	70903	70847	70791
70736	70680	70624	70569	70513	70458	70403	70348	70293
70238	70183	70128	70073	70019	69964	69910	69856	69801
69747	69693	69639	69585	69531	69477	69424	69370	69316
69263	69210	69156	69103	69050	68997	68944	68891	68838
68786	68733	68681	68628	68576	68523	68471	68419	68367
68315	68263	68211	68159	68108	68056	68005	67953	67902
67851	67799	67748	67697	67646	67595	67545	67494	67443
67392	67342	67292	67241	67191	67141	67091	67040	66990
66941	66891	66841	66791	66742	66692	66643	66593	66544
66495	66445	66396	66347	66298	66249	66201	66152	66103
66055	66006	65958	65909	65861	65813	65764	65716	65668
65620	65572	65525	65477	65429	65382	65334	65286	65239
65192	65144	65097	65050	65003	64956	64909	64862	64815

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

64769	64722	64675	64629	64582	64536	64490	64443	64397
64351	64305	64259	64213	64167	64122	64076	64030	63984
63939	63893	63848	63803	63757	63712	63667	63622	63577
63532	63487	63442	63397	63353	63308	63264	63219	63175
63130	63086	63042	62997	62953	62909	62865	62821	62777
62733	62690	62646	62602	62559	62515	62472	62428	62385
62342	62298	62255	62212	62169	62126	62083	62040	61997
61955	61912	61869	61827	61784	61742	61699	61657	61615
61572	61530	61488	61446	61404	61362	61320	61278	61237
61195	61153	61112	61070	61029	60987	60946	60905	60863
60822	60781	60740	60699	60658	60617	60576	60535	60494
60454	60413	60372	60332	60291	60251	60211	60170	60130
60090	60050	60010	59969	59929	59890	59850	59810	59770
59730	59691	59651	59611	59572	59532	59493	59454	59414
59375	59336	59297	59257	59218	59179	59140	59102	59063
59024	58985	58946	58908	58869	58831	58792	58754	58715
58677	58639	58600	58562	58524	58486	58448	58410	58372
58334	58296	58258	58221	58183	58145	58108	58070	58032
57995	57958	57920	57883	57846	57808	57771	57734	57697
57660	57623	57586	57549	57512	57476	57439	57402	57365
57329	57292	57256	57219	57183	57147	57110	57074	57038
57001	56965	56929	56893	56857	56821	56785	56749	56714
56678	56642	56606	56571	56535	56500	56464	56429	56393
56358	56322	56287	56252	56217	56182	56146	56111	56076
56041	56006	55972	55937	55902	55867	55832	55798	55763
55728	55694	55659	55625	55591	55556	55522	55488	55453
55419	55385	55351	55317	55283	55249	55215	55181	55147
55113	55079	55046	55012	54978	54945	54911	54877	54844
54810	54777	54744	54710	54677	54644	54611	54577	54544
54511	54478	54445	54412	54379	54346	54313	54281	54248
54215	54182	54150	54117	54085	54052	54019	53987	53955
53922	53890	53858	53825	53793	53761	53729	53697	53664
53632	53600	53568	53537	53505	53473	53441	53409	53378
53346	53314	53283	53251	53219	53188	53156	53125	53094
53062	53031	53000	52968	52937	52906	52875	52844	52813
52782	52751	52720	52689	52658	52627	52596	52565	52535
52504	52473	52443	52412	52382	52351	52321	52290	52260

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

52229	52199	52169	52138	52108	52078	52048	52018	51987
51957	51927	51897	51867	51838	51808	51778	51748	51718
51688	51659	51629	51599	51570	51540	51511	51481	51452
51422	51393	51363	51334	51305	51275	51246	51217	51188
51159	51129	51100	51071	51042	51013	50984	50955	50927
50898	50869	50840	50811	50783	50754	50725	50697	50668
50639	50611	50582	50554	50526	50497	50469	50440	50412
50384	50356	50327	50299	50271	50243	50215	50187	50159
50131	50103	50075	50047	50019	49991	49964	49936	49908
49880	49853	49825	49797	49770	49742	49715	49687	49660
49632	49605	49578	49550	49523	49496	49468	49441	49414
49387	49360	49332	49305	49278	49251	49224	49197	49170
49144	49117	49090	49063	49036	49010	48983	48956	48929
48903	48876	48850	48823	48797	48770	48744	48717	48691
48664	48638	48612	48585	48559	48533	48507	48481	48454
48428	48402	48376	48350	48324	48298	48272	48246	48220
48194	48169	48143	48117	48091	48066	48040	48014	47988
47963	47937	47912	47886	47861	47835	47810	47784	47759
47734	47708	47683	47658	47632	47607	47582	47557	47531
47506	47481	47456	47431	47406	47381	47356	47331	47306
47281	47256	47232	47207	47182	47157	47132	47108	47083
47058	47034	47009	46985	46960	46935	46911	46886	46862
46838	46813	46789	46764	46740	46716	46692	46667	46643
46619	46595	46571	46546	46522	46498	46474	46450	46426
46402	46378	46354	46330	46306	46283	46259	46235	46211
46187	46164	46140	46116	46093	46069	46045	46022	45998
45975	45951	45928	45904	45881	45857	45834	45811	45787
45764	45741	45717	45694	45671	45648	45624	45601	45578
45555	45532	45509	45486	45463	45440	45417	45394	45371
45348	45325	45302	45279	45257	45234	45211	45188	45166
45143	45120	45098	45075	45052	45030	45007	44985	44962
44940	44917	44895	44872	44850	44828	44805	44783	44761
44738	44716	44694	44672	44649	44627	44605	44583	44561
44539	44517	44495	44473	44451	44429	44407	44385	44363
44341	44319	44297	44275	44253	44232	44210	44188	44166
44145	44123	44101	44080	44058	44037	44015	43993	43972
43950	43929	43907	43886	43865	43843	43822	43800	43779

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

43758	43736	43715	43694	43673	43651	43630	43609	43588
43567	43546	43524	43503	43482	43461	43440	43419	43398
43377	43356	43336	43315	43294	43273	43252	43231	43210
43190	43169	43148	43127	43107	43086	43065	43045	43024
43004	42983	42962	42942	42921	42901	42880	42860	42840
42819	42799	42778	42758	42738	42717	42697	42677	42656
42636	42616	42596	42576	42555	42535	42515	42495	42475
42455	42435	42415	42395	42375	42355	42335	42315	42295
42275	42255	42235	42216	42196	42176	42156	42136	42117
42097	42077	42057	42038	42018	41998	41979	41959	41940
41920	41900	41881	41861	41842	41822	41803	41784	41764
41745	41725	41706	41687	41667	41648	41629	41609	41590
41571	41552	41532	41513	41494	41475	41456	41437	41418
41398	41379	41360	41341	41322	41303	41284	41265	41246
41227	41209	41190	41171	41152	41133	41114	41095	41077
41058	41039	41020	41002	40983	40964	40946	40927	40908
40890	40871	40852	40834	40815	40797	40778	40760	40741
40723	40704	40686	40668	40649	40631	40612	40594	40576
40557	40539	40521	40503	40484	40466	40448	40430	40411
40393	40375	40357	40339	40321	40303	40285	40267	40248
40230	40212	40194	40176	40159	40141	40123	40105	40087
40069	40051	40033	40015	39998	39980	39962	39944	39927
39909	39891	39873	39856	39838	39820	39803	39785	39767
39750	39732	39715	39697	39680	39662	39645	39627	39610
39592	39575	39557	39540	39523	39505	39488	39470	39453
39436	39418	39401	39384	39367	39349	39332	39315	39298
39281	39263	39246	39229	39212	39195	39178	39161	39144
39127	39110	39093	39076	39059	39042	39025	39008	38991
38974	38957	38940	38923	38906	38889	38873	38856	38839
38822	38805	38789	38772	38755	38739	38722	38705	38688
38672	38655	38639	38622	38605	38589	38572	38556	38539
38523	38506	38490	38473	38457	38440	38424	38407	38391
38375	38358	38342	38325	38309	38293	38276	38260	38244
38228	38211	38195	38179	38163	38146	38130	38114	38098
38082	38066	38049	38033	38017	38001	37985	37969	37953
37937	37921	37905	37889	37873	37857	37841	37825	37809
37793	37777	37762	37746	37730	37714	37698	37682	37667

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

37651	37635	37619	37603	37588	37572	37556	37541	37525
37509	37494	37478	37462	37447	37431	37416	37400	37384
37369	37353	37338	37322	37307	37291	37276	37260	37245
37229	37214	37199	37183	37168	37152	37137	37122	37106
37091	37076	37061	37045	37030	37015	36999	36984	36969
36954	36939	36923	36908	36893	36878	36863	36848	36833
36818	36802	36787	36772	36757	36742	36727	36712	36697
36682	36667	36652	36637	36622	36607	36593	36578	36563
36548	36533	36518	36503	36489	36474	36459	36444	36429
36415	36400	36385	36370	36356	36341	36326	36312	36297
36282	36268	36253	36238	36224	36209	36195	36180	36165
36151	36136	36122	36107	36093	36078	36064	36049	36035
36020	36006	35991	35977	35963	35948	35934	35920	35905
35891	35877	35862	35848	35834	35819	35805	35791	35776
35762	35748	35734	35720	35705	35691	35677	35663	35649
35635	35620	35606	35592	35578	35564	35550	35536	35522
35508	35494	35480	35466	35452	35438	35424	35410	35396
35382	35368	35354	35340	35326	35312	35299	35285	35271
35257	35243	35229	35216	35202	35188	35174	35160	35147
35133	35119	35105	35092	35078	35064	35051	35037	35023
35010	34996	34982	34969	34955	34942	34928	34914	34901
34887	34874	34860	34847	34833	34820	34806	34793	34779
34766	34752	34739	34725	34712	34699	34685	34672	34658
34645	34632	34618	34605	34592	34578	34565	34552	34539
34525	34512	34499	34486	34472	34459	34446	34433	34419
34406	34393	34380	34367	34354	34341	34327	34314	34301
34288	34275	34262	34249	34236	34223	34210	34197	34184
34171	34158	34145	34132	34119	34106	34093	34080	34067
34054	34041	34028	34015	34003	33990	33977	33964	33951
33938	33926	33913	33900	33887	33874	33862	33849	33836
33823	33811	33798	33785	33773	33760	33747	33734	33722
33709	33696	33684	33671	33659	33646	33633	33621	33608
33596	33583	33571	33558	33546	33533	33520	33508	33495
33483	33471	33458	33446	33433	33421	33408	33396	33383
33371	33359	33346	33334	33322	33309	33297	33285	33272
33260	33248	33235	33223	33211	33198	33186	33174	33162
33149	33137	33125	33113	33101	33088	33076	33064	33052

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

33040	33028	33015	33003	32991	32979	32967	32955	32943
32931	32919	32907	32895	32882	32870	32858	32846	32834
32822	32810	32798	32786	32775	32763	32751	32739	32727
32715	32703	32691	32679	32667	32655	32643	32632	32620
32608	32596	32584	32572	32561	32549	32537	32525	32514
32502	32490	32478	32467	32455	32443	32431	32420	32408
32396	32385	32373	32361	32350	32338	32326	32315	32303
32291	32280	32268	32257	32245	32234	32222	32210	32199
32187	32176	32164	32153	32141	32130	32118	32107	32095
32084	32072	32061	32050	32038	32027	32015	32004	31992
31981	31970	31958	31947	31936	31924	31913	31902	31890
31879	31868	31856	31845	31834	31823	31811	31800	31789
31777	31766	31755	31744	31733	31721	31710	31699	31688
31677	31665	31654	31643	31632	31621	31610	31599	31588
31576	31565	31554	31543	31532	31521	31510	31499	31488
31477	31466	31455	31444	31433	31422	31411	31400	31389
31378	31367	31356	31345	31334	31323	31312	31301	31290
31280	31269	31258	31247	31236	31225	31214	31204	31193
31182	31171	31160	31149	31139	31128	31117	31106	31096
31085	31074	31063	31053	31042	31031	31020	31010	30999
30988	30978	30967	30956	30946	30935	30924	30914	30903
30892	30882	30871	30861	30850	30839	30829	30818	30808
30797	30786	30776	30765	30755	30744	30734	30723	30713
30702	30692	30681	30671	30660	30650	30639	30629	30619
30608	30598	30587	30577	30567	30556	30546	30535	30525
30515	30504	30494	30484	30473	30463	30453	30442	30432
30422	30411	30401	30391	30380	30370	30360	30350	30339
30329	30319	30309	30298	30288	30278	30268	30258	30247
30237	30227	30217	30207	30197	30186	30176	30166	30156
30146	30136	30126	30116	30106	30095	30085	30075	30065
30055	30045	30035	30025	30015	30005	29995	29985	29975
29965	29955	29945	29935	29925	29915	29905	29895	29885
29875	29865	29855	29846	29836	29826	29816	29806	29796
29786	29776	29766	29757	29747	29737	29727	29717	29707
29698	29688	29678	29668	29658	29649	29639	29629	29619
29609	29600	29590	29580	29570	29561	29551	29541	29532
29522	29512	29502	29493	29483	29473	29464	29454	29444

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

29435	29425	29416	29406	29396	29387	29377	29367	29358
29348	29339	29329	29320	29310	29300	29291	29281	29272
29262	29253	29243	29234	29224	29215	29205	29196	29186
29177	29167	29158	29148	29139	29129	29120	29111	29101
29092	29082	29073	29063	29054	29045	29035	29026	29016
29007	28998	28988	28979	28970	28960	28951	28942	28932
28923	28914	28904	28895	28886	28877	28867	28858	28849
28840	28830	28821	28812	28803	28793	28784	28775	28766
28756	28747	28738	28729	28720	28710	28701	28692	28683
28674	28665	28656	28646	28637	28628	28619	28610	28601
28592	28583	28574	28564	28555	28546	28537	28528	28519
28510	28501	28492	28483	28474	28465	28456	28447	28438
28429	28420	28411	28402	28393	28384	28375	28366	28357
28348	28339	28330	28321	28312	28303	28295	28286	28277
28268	28259	28250	28241	28232	28223	28215	28206	28197
28188	28179	28170	28161	28153	28144	28135	28126	28117
28109	28100	28091	28082	28073	28065	28056	28047	28038
28030	28021	28012	28003	27995	27986	27977	27969	27960
27951	27943	27934	27925	27916	27908	27899	27890	27882
27873	27864	27856	27847	27839	27830	27821	27813	27804
27796	27787	27778	27770	27761	27753	27744	27735	27727
27718	27710	27701	27693	27684	27676	27667	27659	27650
27642	27633	27625	27616	27608	27599	27591	27582	27574
27565	27557	27548	27540	27531	27523	27515	27506	27498
27489	27481	27473	27464	27456	27447	27439	27431	27422
27414	27405	27397	27389	27380	27372	27364	27355	27347
27339	27330	27322	27314	27306	27297	27289	27281	27272
27264	27256	27248	27239	27231	27223	27215	27206	27198
27190	27182	27173	27165	27157	27149	27141	27132	27124
27116	27108	27100	27091	27083	27075	27067	27059	27051
27043	27034	27026	27018	27010	27002	26994	26986	26978
26969	26961	26953	26945	26937	26929	26921	26913	26905
26897	26889	26881	26873	26865	26857	26849	26841	26832
26824	26816	26808	26800	26792	26784	26777	26769	26761
26753	26745	26737	26729	26721	26713	26705	26697	26689
26681	26673	26665	26657	26649	26642	26634	26626	26618
26610	26602	26594	26586	26578	26571	26563	26555	26547

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

26539	26531	26524	26516	26508	26500	26492	26484	26477
26469	26461	26453	26445	26438	26430	26422	26414	26407
26399	26391	26383	26376	26368	26360	26352	26345	26337
26329	26321	26314	26306	26298	26291	26283	26275	26268
26260	26252	26245	26237	26229	26222	26214	26206	26199
26191	26183	26176	26168	26161	26153	26145	26138	26130
26122	26115	26107	26100	26092	26085	26077	26069	26062
26054	26047	26039	26032	26024	26017	26009	26002	25994
25986	25979	25971	25964	25956	25949	25941	25934	25926
25919	25912	25904	25897	25889	25882	25874	25867	25859
25852	25844	25837	25830	25822	25815	25807	25800	25792
25785	25778	25770	25763	25756	25748	25741	25733	25726
25719	25711	25704	25697	25689	25682	25675	25667	25660
25653	25645	25638	25631	25623	25616	25609	25601	25594
25587	25580	25572	25565	25558	25550	25543	25536	25529
25521	25514	25507	25500	25492	25485	25478	25471	25464
25456	25449	25442	25435	25427	25420	25413	25406	25399
25392	25384	25377	25370	25363	25356	25349	25341	25334
25327	25320	25313	25306	25299	25291	25284	25277	25270
25263	25256	25249	25242	25235	25228	25220	25213	25206
25199	25192	25185	25178	25171	25164	25157	25150	25143
25136	25129	25122	25115	25108	25101	25094	25087	25080
25073	25066	25059	25052	25045	25038	25031	25024	25017
25010	25003	24996	24989	24982	24975	24968	24961	24954
24947	24940	24933	24927	24920	24913	24906	24899	24892
24885	24878	24871	24864	24858	24851	24844	24837	24830
24823	24816	24810	24803	24796	24789	24782	24775	24768
24762	24755	24748	24741	24734	24728	24721	24714	24707
24700	24694	24687	24680	24673	24666	24660	24653	24646
24639	24633	24626	24619	24612	24606	24599	24592	24585
24579	24572	24565	24559	24552	24545	24538	24532	24525
24518	24512	24505	24498	24492	24485	24478	24472	24465
24458	24452	24445	24438	24432	24425	24418	24412	24405
24399	24392	24385	24379	24372	24365	24359	24352	24346
24339	24332	24326	24319	24313	24306	24300	24293	24286
24280	24273	24267	24260	24254	24247	24241	24234	24227
24221	24214	24208	24201	24195	24188	24182	24175	24169

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

24162	24156	24149	24143	24136	24130	24123	24117	24110
24104	24097	24091	24085	24078	24072	24065	24059	24052
24046	24039	24033	24027	24020	24014	24007	24001	23994
23988	23982	23975	23969	23962	23956	23950	23943	23937
23931	23924	23918	23911	23905	23899	23892	23886	23880
23873	23867	23861	23854	23848	23842	23835	23829	23823
23816	23810	23804	23797	23791	23785	23779	23772	23766
23760	23753	23747	23741	23735	23728	23722	23716	23710
23703	23697	23691	23685	23678	23672	23666	23660	23653
23647	23641	23635	23628	23622	23616	23610	23604	23597
23591	23585	23579	23573	23566	23560	23554	23548	23542
23536	23529	23523	23517	23511	23505	23499	23493	23486
23480	23474	23468	23462	23456	23450	23443	23437	23431
23425	23419	23413	23407	23401	23395	23389	23382	23376
23370	23364	23358	23352	23346	23340	23334	23328	23322
23316	23310	23304	23298	23292	23286	23279	23273	23267
23261	23255	23249	23243	23237	23231	23225	23219	23213
23207	23201	23195	23189	23183	23177	23171	23165	23159
23153	23148	23142	23136	23130	23124	23118	23112	23106
23100	23094	23088	23082	23076	23070	23064	23058	23052
23047	23041	23035	23029	23023	23017	23011	23005	22999
22993	22988	22982	22976	22970	22964	22958	22952	22946
22941	22935	22929	22923	22917	22911	22906	22900	22894
22888	22882	22876	22871	22865	22859	22853	22847	22841
22836	22830	22824	22818	22812	22807	22801	22795	22789
22784	22778	22772	22766	22760	22755	22749	22743	22737
22732	22726	22720	22714	22709	22703	22697	22691	22686
22680	22674	22669	22663	22657	22651	22646	22640	22634
22629	22623	22617	22612	22606	22600	22594	22589	22583
22577	22572	22566	22560	22555	22549	22543	22538	22532
22526	22521	22515	22510	22504	22498	22493	22487	22481
22476	22470	22464	22459	22453	22448	22442	22436	22431
22425	22420	22414	22408	22403	22397	22392	22386	22381
22375	22369	22364	22358	22353	22347	22342	22336	22330
22325	22319	22314	22308	22303	22297	22292	22286	22281
22275	22270	22264	22259	22253	22248	22242	22237	22231
22226	22220	22215	22209	22204	22198	22193	22187	22182

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

22176	22171	22165	22160	22154	22149	22143	22138	22132
22127	22122	22116	22111	22105	22100	22094	22089	22083
22078	22073	22067	22062	22056	22051	22046	22040	22035
22029	22024	22019	22013	22008	22002	21997	21992	21986
21981	21975	21970	21965	21959	21954	21949	21943	21938
21933	21595	21268	20950	20642	20343	20053	19770	19496
19229	18969	18716	18470	18230	17996	17768	17546	17329
17118	16912	16711	16514	16322	16134	15951	15772	15597
15425	15258	15093	14933	14776	14622	14471	14323	14179
14037	13898	13762	13628	13497	13369	13242	13119	12997
12878	12761	12646	12533	12422	12313	12206	12101	11997
11896	11796	11698	11601	11506	11412	11320	11230	11141
11053	10967	10881	10798	10715	10634	10554	10475	10398
10321	10246	10172	10099	10027	9955	9885	9816	9748
9681	9615	9549	9485	9421	9358	9296	9235	9175
9115	9056	8998	8941	8884	8828	8773	8719	8665
8612	8559	8507	8456	8406	8356	8306	8257	8209
8161	8114	8067	8021	7976	7931	7886	7842	7799
7755	7713	7671	7629	7588	7547	7507	7467	7427
7388	7349	7311	7273	7236	7199	7162	7126	7090
7054	7019	6984	6949	6915	6881	6848	6814	6781
6749	6717	6685	6653	6621	6590	6560	6529	6499
6469	6439	6410	6381	6352	6323	6295	6267	6239
6211	6184	6157	6130	6103	6077	6051	6025	5999
5973	5948	5923	5898	5874	5849	5825	5801	5777
5753	5730	5706	5683	5660	5638	5615	5593	5571
5549	5527	5505	5484	5462	5441	5420	5399	5378
5358	5338	5317	5297	5277	5258	5238	5219	5199
5180	5161	5142	5123	5105	5086	5068	5050	5031
5014	4996	4978	4960	4943	4926	4908	4891	4874
4857	4841	4824	4808	4791	4775	4759	4743	4727
4711	4695	4679	4664	4648	4633	4618	4603	4588
4573	4558	4543	4528	4514	4499	4485	4471	4457
4442	4428	4414	4401	4387	4373	4360	4346	4333
4319	4306	4293	4280	4267	4254	4241	4228	4216
4203	4190	4178	4166	4153	4141	4129	4117	4105
4093	4081	4069	4057	4046	4034	4022	4011	3999

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

3988	3977	3966	3954	3943	3932	3921	3910	3900
3889	3878	3867	3857	3846	3836	3825	3815	3804
3794	3784	3774	3764	3754	3744	3734	3724	3714
3704	3694	3685	3675	3665	3656	3646	3637	3627
3618	3609	3600	3590	3581	3572	3563	3554	3545
3536	3527	3518	3510	3501	3492	3483	3475	3466
3458	3449	3441	3432	3424	3416	3407	3399	3391
3383	3375	3367	3359	3350	3343	3335	3327	3319
3311	3303	3295	3288	3280	3272	3265	3257	3250
3242	3235	3227	3220	3213	3205	3198	3191	3183
3176	3169	3162	3155	3148	3141	3134	3127	3120
3113	3106	3099	3092	3085	3079	3072	3065	3059
3052	3045	3039	3032	3026	3019	3013	3006	3000
2993	2987	2981	2974	2968	2962	2956	2949	2943
2937	2931	2925	2919	2913	2907	2901	2895	2889
2883	2877	2871	2865	2859	2853	2848	2842	2836
2830	2825	2819	2813	2808	2802	2797	2791	2786
2780	2775	2769	2764	2758	2753	2747	2742	2737
2731	2726	2721	2715	2710	2705	2700	2695	2689
2684	2679	2674	2669	2664	2659	2654	2649	2644
2639	2634	2629	2624	2619	2614	2610	2605	2600
2595	2590	2585	2581	2576	2571	2567	2562	2557
2553	2548	2543	2539	2534	2530	2525	2521	2516
2511	2507	2503	2498	2494	2489	2485	2480	2476
2472	2467	2463	2459	2454	2450	2446	2442	2437
2433	2429	2425	2421	2416	2412	2408	2404	2400
2396	2392	2388	2384	2380	2376	2372	2368	2364
2360	2356	2352	2348	2344	2340	2336	2332	2328
2324	2321	2317	2313	2309	2305	2302	2298	2294
2290	2287	2283	2279	2275	2272	2268	2264	2261
2257	2254	2250	2246	2243	2239	2236	2232	2229
2225	2221	2218	2214	2211	2207	2204	2201	2197
2194	2190	2187	2183	2180	2177	2173	2170	2167
2163	2160	2157	2153	2150	2147	2143	2140	2137
2134	2130	2127	2124	2121	2118	2114	2111	2108
2105	2102	2099	2095	2092	2089	2086	2083	2080
2077	2074	2071	2068	2065	2062	2059	2056	2053

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

2050	2047	2044	2041	2038	2035	2032	2029	2026
2023	2020	2017	2014	2011	2009	2006	2003	2000
1997	1994	1991	1989	1986	1983	1980	1977	1975
1972	1969	1966	1964	1961	1958	1955	1953	1950
1947	1945	1942	1939	1937	1934	1931	1929	1926
1923	1921	1918	1915	1913	1910	1908	1905	1902
1900	1897	1895	1892	1890	1887	1885	1882	1880
1877	1875	1872	1870	1867	1865	1862	1860	1857
1855	1852	1850	1847	1845	1843	1840	1838	1835
1833	1831	1828	1826	1823	1821	1819	1816	1814
1812	1809	1807	1805	1802	1800	1798	1795	1793
1791	1789	1786	1784	1782	1780	1777	1775	1773
1771	1768	1766	1764	1762	1759	1757	1755	1753
1751	1749	1746	1744	1742	1740	1738	1736	1733
1731	1729	1727	1725	1723	1721	1719	1716	1714
1712	1710	1708	1706	1704	1702	1700	1698	1696
1694	1692	1690	1688	1686	1684	1682	1680	1677
1675	1674	1672	1670	1668	1666	1664	1662	1660
1658	1656	1654	1652	1650	1648	1646	1644	1642
1640	1638	1636	1635	1633	1631	1629	1627	1625
1623	1621	1619	1618	1616	1614	1612	1610	1608
1607	1605	1603	1601	1599	1597	1596	1594	1592
1590	1588	1587	1585	1583	1581	1579	1578	1576
1574	1572	1571	1569	1567	1565	1564	1562	1560
1558	1557	1555	1553	1551	1550	1548	1546	1545
1543	1541	1540	1538	1536	1535	1533	1531	1530
1528	1526	1525	1523	1521	1520	1518	1516	1515
1513	1511	1510	1508	1507	1505	1503	1502	1500
1499	1497	1495	1494	1492	1491	1489	1487	1486
1484	1483	1481	1480	1478	1476	1475	1473	1472
1470	1469	1467	1466	1464	1463	1461	1460	1458
1457	1455	1454	1452	1451	1449	1448	1446	1445
1443	1442	1440	1439	1437	1436	1434	1433	1431
1430	1428	1427	1426	1424	1423	1421	1420	1418
1417	1415	1414	1413	1411	1410	1408	1407	1406
1404	1403	1401	1400	1399	1397	1396	1394	1393
1392	1390	1389	1388	1386	1385	1383	1382	1381

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

1379	1378	1377	1375	1374	1373	1371	1370	1369
1367	1366	1365	1363	1362	1361	1359	1358	1357
1355	1354	1353	1351	1350	1349	1348	1346	1345
1344	1342	1341	1340	1339	1337	1336	1335	1333
1332	1331	1330	1328	1327	1326	1325	1323	1322
1321	1320	1318	1317	1316	1315	1314	1312	1311
1310	1309	1307	1306	1305	1304	1303	1301	1300
1299	1298	1297	1295	1294	1293	1292	1291	1289
1288	1287	1286	1285	1284	1282	1281	1280	1279
1278	1277	1275	1274	1273	1272	1271	1270	1268
1267	1266	1265	1264	1263	1262	1261	1259	1258
1257	1256	1255	1254	1253	1252	1250	1249	1248
1247	1246	1245	1244	1243	1242	1240	1239	1238
1237	1236	1235	1234	1233	1232	1231	1230	1229
1227	1226	1225	1224	1223	1222	1221	1220	1219
1218	1217	1216	1215	1214	1213	1212	1211	1209
1208	1207	1206	1205	1204	1203	1202	1201	1200
1199	1198	1197	1196	1195	1194	1193	1192	1191
1190	1189	1188	1187	1186	1185	1184	1183	1182
1181	1180	1179	1178	1177	1176	1175	1174	1173
1172	1171	1170	1169	1168	1167	1166	1165	1164
1163	1162	1161	1160	1159	1158	1157	1156	1155
1154	1153	1152	1151	1150	1149	1148	1147	1146
1145	1144	1143	1142	1141	1140	1139	1138	1137
1136	1135	1134	1133	1132	1131	1130	1129	1128
1127	1126	1125	1124	1123	1122	1121	1120	1119
1118	1117	1116	1115	1114	1113	1112	1111	1110
1109	1108	1107	1106	1105	1104	1103	1102	1101
1100	1099	1098	1097	1096	1095	1094	1093	1092
1091	1090	1089	1088	1087	1086	1085	1084	1083
1082	1081	1080	1079	1078	1077	1076	1075	1074
1073	1072	1071	1070	1069	1068	1067	1066	1065
1064	1063	1062	1061	1060	1059	1058	1057	1056
1055	1054	1053	1052	1051	1050	1049	1048	1047
1046	1045	1044	1043	1042	1041	1040	1039	1038
1037	1036	1035	1034	1033	1032	1031	1030	1029
1028	1027	1026	1025	1024	1023	1022	1021	1020

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

1019	1018	1017	1016	1015	1014	1013	1012	1011
1010	1009	1008	1007	1006	1005	1004	1003	1002
1001	1000	999	998	997	996	995	994	993
992	991	990	989	988	987	986	985	984
983	982	981	980	979	978	977	976	975
974	973	972	971	970	969	968	967	966
965	964	963	962	961	960	959	958	957
956	955	954	953	952	951	950	949	948
947	946	945	944	943	942	941	940	939
938	937	936	935	934	933	932	931	930
929	928	927	926	925	924	923	922	921
920	919	918	917	916	915	914	913	912
911	910	909	908	907	906	905	904	903
902	901	900	899	898	897	896	895	894
893	892	891	890	889	888	887	886	885
884	883	882	881	880	879	878	877	876
875	874	873	872	871	870	869	868	867
866	865	864	863	862	861	860	859	858
857	856	855	854	853	852	851	850	849
848	847	846	845	844	843	842	841	840
839	838	837	836	835	834	833	832	831
830	829	828	827	826	825	824	823	822
821	820	819	818	817	816	815	814	813
812	811	810	809	808	807	806	805	804
803	802	801	800	799	798	797	796	795
794	793	792	791	790	789	788	787	786
785	784	783	782	781	780	779	778	777
776	775	774	773	772	771	770	769	768
767	766	765	764	763	762	761	760	759
758	757	756	755	754	753	752	751	750
749	748	747	746	745	744	743	742	741
740	739	738	737	736	735	734	733	732
731	730	729	728	727	726	725	724	723
722	721	720	719	718	717	716	715	714
713	712	711	710	709	708	707	706	705
704	703	702	701	700	699	698	697	696
695	694	693	692	691	690	689	688	687

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

686	685	684	683	682	681	680	679	678
677	676	675	674	673	672	671	670	669
668	667	666	665	664	663	662	661	660
659	658	657	656	655	654	653	652	651
650	649	648	647	646	645	644	643	642
641	640	639	638	637	636	635	634	633
632	631	630	629	628	627	626	625	624
623	622	621	620	619	618	617	616	615
614	613	612	611	610	609	608	607	606
605	604	603	602	601	600	599	598	597
596	595	594	593	592	591	590	589	588
587	586	585	584	583	582	581	580	579
578	577	576	575	574	573	572	571	570
569	568	567	566	565	564	563	562	561
560	559	558	557	556	555	554	553	552
551	550	549	548	547	546	545	544	543
542	541	540	539	538	537	536	535	534
533	532	531	530	529	528	527	526	525
524	523	522	521	520	519	518	517	516
515	514	513	512	511	510	509	508	507
506	505	504	503	502	501	500	499	498
497	496	495	494	493	492	491	490	489
488	487	486	485	484	483	482	481	480
479	478	477	476	475	474	473	472	471
470	469	468	467	466	465	464	463	462
461	460	459	458	457	456	455	454	453
452	451	450	449	448	447	446	445	444
443	442	441	440	439	438	437	436	435
434	433	432	431	430	429	428	427	426
425	424	423	422	421	420	419	418	417
416	415	414	413	412	411	410	409	408
407	406	405	404	403	402	401	400	399
398	397	396	395	394	393	392	391	390
389	388	387	386	385	384	383	382	381
380	379	378	377	376	375	374	373	372
371	370	369	368	367	366	365	364	363
362	361	360	359	358	357	356	355	354

Table 23-6 Best-Effort and VBR Shaping (PCR-Only Mode) Rates for OC-12 (Cells Per Second)

353	352	351	350	349	348	347	346	345
344	343							

Table 23-7 shows the OC-12 rates for VBR connections that are shaped using their PCR, SCR and MBS parameters (the default shaping mode).

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second)

1403649	701825	467883	350913	280730	233942	200522	175457	155961
140365	127605	116971	107973	100261	93577	87729	82568	77981
73877	70183	66841	63803	61029	58486	56146	53987	51987
50131	48402	46789	45279	43865	42535	41284	40105	38991
37937	36939	35991	35092	34236	33421	32643	31902	31193
30515	29865	29243	28646	28073	27523	26994	26484	25994
25521	25066	24626	24201	23791	23395	23011	22640	22281
21933	21595	21268	20950	20642	20343	20053	19770	19496
19229	18969	18716	18470	18230	17996	17768	17546	17329
17118	16912	16711	16514	16322	16134	15951	15772	15597
15425	15258	15093	14933	14776	14622	14471	14323	14179
14037	13898	13762	13628	13497	13369	13242	13119	12997
12878	12761	12646	12533	12422	12313	12206	12101	11997
11896	11796	11698	11601	11506	11412	11320	11230	11141
11053	10967	10881	10798	10715	10634	10554	10475	10398
10321	10246	10172	10099	10027	9955	9885	9816	9748
9681	9615	9549	9485	9421	9358	9296	9235	9175
9115	9056	8998	8941	8884	8828	8773	8719	8665
8612	8559	8507	8456	8406	8356	8306	8257	8209
8161	8114	8067	8021	7976	7931	7886	7842	7799
7755	7713	7671	7629	7588	7547	7507	7467	7427
7388	7349	7311	7273	7236	7199	7162	7126	7090
7054	7019	6984	6949	6915	6881	6848	6814	6781
6749	6717	6685	6653	6621	6590	6560	6529	6499
6469	6439	6410	6381	6352	6323	6295	6267	6239
6211	6184	6157	6130	6103	6077	6051	6025	5999
5973	5948	5923	5898	5874	5849	5825	5801	5777
5753	5730	5706	5683	5660	5638	5615	5593	5571
5549	5527	5505	5484	5462	5441	5420	5399	5378
5358	5338	5317	5297	5277	5258	5238	5219	5199

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

5180	5161	5142	5123	5105	5086	5068	5050	5031
5014	4996	4978	4960	4943	4926	4908	4891	4874
4857	4841	4824	4808	4791	4775	4759	4743	4727
4711	4695	4679	4664	4648	4633	4618	4603	4588
4573	4558	4543	4528	4514	4499	4485	4471	4457
4442	4428	4414	4401	4387	4373	4360	4346	4333
4319	4306	4293	4280	4267	4254	4241	4228	4216
4203	4190	4178	4166	4153	4141	4129	4117	4105
4093	4081	4069	4057	4046	4034	4022	4011	3999
3988	3977	3966	3954	3943	3932	3921	3910	3900
3889	3878	3867	3857	3846	3836	3825	3815	3804
3794	3784	3774	3764	3754	3744	3734	3724	3714
3704	3694	3685	3675	3665	3656	3646	3637	3627
3618	3609	3600	3590	3581	3572	3563	3554	3545
3536	3527	3518	3510	3501	3492	3483	3475	3466
3458	3449	3441	3432	3424	3416	3407	3399	3391
3383	3375	3367	3359	3350	3343	3335	3327	3319
3311	3303	3295	3288	3280	3272	3265	3257	3250
3242	3235	3227	3220	3213	3205	3198	3191	3183
3176	3169	3162	3155	3148	3141	3134	3127	3120
3113	3106	3099	3092	3085	3079	3072	3065	3059
3052	3045	3039	3032	3026	3019	3013	3006	3000
2993	2987	2981	2974	2968	2962	2956	2949	2943
2937	2931	2925	2919	2913	2907	2901	2895	2889
2883	2877	2871	2865	2859	2853	2848	2842	2836
2830	2825	2819	2813	2808	2802	2797	2791	2786
2780	2775	2769	2764	2758	2753	2747	2742	2737
2731	2726	2721	2715	2710	2705	2700	2695	2689
2684	2679	2674	2669	2664	2659	2654	2649	2644
2639	2634	2629	2624	2619	2614	2610	2605	2600
2595	2590	2585	2581	2576	2571	2567	2562	2557
2553	2548	2543	2539	2534	2530	2525	2521	2516
2511	2507	2503	2498	2494	2489	2485	2480	2476
2472	2467	2463	2459	2454	2450	2446	2442	2437
2433	2429	2425	2421	2416	2412	2408	2404	2400
2396	2392	2388	2384	2380	2376	2372	2368	2364
2360	2356	2352	2348	2344	2340	2336	2332	2328

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

2324	2321	2317	2313	2309	2305	2302	2298	2294
2290	2287	2283	2279	2275	2272	2268	2264	2261
2257	2254	2250	2246	2243	2239	2236	2232	2229
2225	2221	2218	2214	2211	2207	2204	2201	2197
2194	2190	2187	2183	2180	2177	2173	2170	2167
2163	2160	2157	2153	2150	2147	2143	2140	2137
2134	2130	2127	2124	2121	2118	2114	2111	2108
2105	2102	2099	2095	2092	2089	2086	2083	2080
2077	2074	2071	2068	2065	2062	2059	2056	2053
2050	2047	2044	2041	2038	2035	2032	2029	2026
2023	2020	2017	2014	2011	2009	2006	2003	2000
1997	1994	1991	1989	1986	1983	1980	1977	1975
1972	1969	1966	1964	1961	1958	1955	1953	1950
1947	1945	1942	1939	1937	1934	1931	1929	1926
1923	1921	1918	1915	1913	1910	1908	1905	1902
1900	1897	1895	1892	1890	1887	1885	1882	1880
1877	1875	1872	1870	1867	1865	1862	1860	1857
1855	1852	1850	1847	1845	1843	1840	1838	1835
1833	1831	1828	1826	1823	1821	1819	1816	1814
1812	1809	1807	1805	1802	1800	1798	1795	1793
1791	1789	1786	1784	1782	1780	1777	1775	1773
1771	1768	1766	1764	1762	1759	1757	1755	1753
1751	1749	1746	1744	1742	1740	1738	1736	1733
1731	1729	1727	1725	1723	1721	1719	1716	1714
1712	1710	1708	1706	1704	1702	1700	1698	1696
1694	1692	1690	1688	1686	1684	1682	1680	1677
1675	1674	1672	1670	1668	1666	1664	1662	1660
1658	1656	1654	1652	1650	1648	1646	1644	1642
1640	1638	1636	1635	1633	1631	1629	1627	1625
1623	1621	1619	1618	1616	1614	1612	1610	1608
1607	1605	1603	1601	1599	1597	1596	1594	1592
1590	1588	1587	1585	1583	1581	1579	1578	1576
1574	1572	1571	1569	1567	1565	1564	1562	1560
1558	1557	1555	1553	1551	1550	1548	1546	1545
1543	1541	1540	1538	1536	1535	1533	1531	1530
1528	1526	1525	1523	1521	1520	1518	1516	1515
1513	1511	1510	1508	1507	1505	1503	1502	1500

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

1499	1497	1495	1494	1492	1491	1489	1487	1486
1484	1483	1481	1480	1478	1476	1475	1473	1472
1470	1469	1467	1466	1464	1463	1461	1460	1458
1457	1455	1454	1452	1451	1449	1448	1446	1445
1443	1442	1440	1439	1437	1436	1434	1433	1431
1430	1428	1427	1426	1424	1423	1421	1420	1418
1417	1415	1414	1413	1411	1410	1408	1407	1406
1404	1403	1401	1400	1399	1397	1396	1394	1393
1392	1390	1389	1388	1386	1385	1383	1382	1381
1379	1378	1377	1375	1374	1373	1371	1370	1369
1367	1366	1365	1363	1362	1361	1359	1358	1357
1355	1354	1353	1351	1350	1349	1348	1346	1345
1344	1342	1341	1340	1339	1337	1336	1335	1333
1332	1331	1330	1328	1327	1326	1325	1323	1322
1321	1320	1318	1317	1316	1315	1314	1312	1311
1310	1309	1307	1306	1305	1304	1303	1301	1300
1299	1298	1297	1295	1294	1293	1292	1291	1289
1288	1287	1286	1285	1284	1282	1281	1280	1279
1278	1277	1275	1274	1273	1272	1271	1270	1268
1267	1266	1265	1264	1263	1262	1261	1259	1258
1257	1256	1255	1254	1253	1252	1250	1249	1248
1247	1246	1245	1244	1243	1242	1240	1239	1238
1237	1236	1235	1234	1233	1232	1231	1230	1229
1227	1226	1225	1224	1223	1222	1221	1220	1219
1218	1217	1216	1215	1214	1213	1212	1211	1209
1208	1207	1206	1205	1204	1203	1202	1201	1200
1199	1198	1197	1196	1195	1194	1193	1192	1191
1190	1189	1188	1187	1186	1185	1184	1183	1182
1181	1180	1179	1178	1177	1176	1175	1174	1173
1172	1171	1170	1169	1168	1167	1166	1165	1164
1163	1162	1161	1160	1159	1158	1157	1156	1155
1154	1153	1152	1151	1150	1149	1148	1147	1146
1145	1144	1143	1142	1141	1140	1139	1138	1137
1136	1135	1134	1133	1132	1131	1130	1129	1128
1127	1126	1125	1124	1123	1122	1121	1120	1119
1118	1117	1116	1115	1114	1113	1112	1111	1110
1109	1108	1107	1106	1105	1104	1103	1102	1101

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

1100	1099	1098	1097	1096	1095	1094	1093	1092
1091	1090	1089	1088	1087	1086	1085	1084	1083
1082	1081	1080	1079	1078	1077	1076	1075	1074
1073	1072	1071	1070	1069	1068	1067	1066	1065
1064	1063	1062	1061	1060	1059	1058	1057	1056
1055	1054	1053	1052	1051	1050	1049	1048	1047
1046	1045	1044	1043	1042	1041	1040	1039	1038
1037	1036	1035	1034	1033	1032	1031	1030	1029
1028	1027	1026	1025	1024	1023	1022	1021	1020
1019	1018	1017	1016	1015	1014	1013	1012	1011
1010	1009	1008	1007	1006	1005	1004	1003	1002
1001	1000	999	998	997	996	995	994	993
992	991	990	989	988	987	986	985	984
983	982	981	980	979	978	977	976	975
974	973	972	971	970	969	968	967	966
965	964	963	962	961	960	959	958	957
956	955	954	953	952	951	950	949	948
947	946	945	944	943	942	941	940	939
938	937	936	935	934	933	932	931	930
929	928	927	926	925	924	923	922	921
920	919	918	917	916	915	914	913	912
911	910	909	908	907	906	905	904	903
902	901	900	899	898	897	896	895	894
893	892	891	890	889	888	887	886	885
884	883	882	881	880	879	878	877	876
875	874	873	872	871	870	869	868	867
866	865	864	863	862	861	860	859	858
857	856	855	854	853	852	851	850	849
848	847	846	845	844	843	842	841	840
839	838	837	836	835	834	833	832	831
830	829	828	827	826	825	824	823	822
821	820	819	818	817	816	815	814	813
812	811	810	809	808	807	806	805	804
803	802	801	800	799	798	797	796	795
794	793	792	791	790	789	788	787	786
785	784	783	782	781	780	779	778	777
776	775	774	773	772	771	770	769	768

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

767	766	765	764	763	762	761	760	759
758	757	756	755	754	753	752	751	750
749	748	747	746	745	744	743	742	741
740	739	738	737	736	735	734	733	732
731	730	729	728	727	726	725	724	723
722	721	720	719	718	717	716	715	714
713	712	711	710	709	708	707	706	705
704	703	702	701	700	699	698	697	696
695	694	693	692	691	690	689	688	687
686	685	684	683	682	681	680	679	678
677	676	675	674	673	672	671	670	669
668	667	666	665	664	663	662	661	660
659	658	657	656	655	654	653	652	651
650	649	648	647	646	645	644	643	642
641	640	639	638	637	636	635	634	633
632	631	630	629	628	627	626	625	624
623	622	621	620	619	618	617	616	615
614	613	612	611	610	609	608	607	606
605	604	603	602	601	600	599	598	597
596	595	594	593	592	591	590	589	588
587	586	585	584	583	582	581	580	579
578	577	576	575	574	573	572	571	570
569	568	567	566	565	564	563	562	561
560	559	558	557	556	555	554	553	552
551	550	549	548	547	546	545	544	543
542	541	540	539	538	537	536	535	534
533	532	531	530	529	528	527	526	525
524	523	522	521	520	519	518	517	516
515	514	513	512	511	510	509	508	507
506	505	504	503	502	501	500	499	498
497	496	495	494	493	492	491	490	489
488	487	486	485	484	483	482	481	480
479	478	477	476	475	474	473	472	471
470	469	468	467	466	465	464	463	462
461	460	459	458	457	456	455	454	453
452	451	450	449	448	447	446	445	444
443	442	441	440	439	438	437	436	435

Table 23-7 VBR Shaping (Using PCR, SCR, and MBS) Rates for OC-12 (Cells Per Second) (continued)

434	433	432	431	430	429	428	427	426
425	424	423	422	421	420	419	418	417
416	415	414	413	412	411	410	409	408
407	406	405	404	403	402	401	400	399
398	397	396	395	394	393	392	391	390
389	388	387	386	385	384	383	382	381
380	379	378	377	376	375	374	373	372
371	370	369	368	367	366	365	364	363
362	361	360	359	358	357	356	355	354
353	352	351	350	349	348	347	346	345
344	343							

Configuring Rate Limiting and Traffic Shaping

This chapter describes rate limiting features and configuration procedures for your Catalyst 8500 switch router.

> **Note** For further information about the commands used in this chapter, refer to the *ATM and Layer 3 Switch Router Command Reference* and the *Cisco IOS Quality of Service Solutions Command Reference*.

This chapter includes the following sections:

Rate Limiting

Rate limiting is available on the Catalyst 8540 MSR, Catalyst 8510 MSR, Catalyst 8540 CSR, and Catalyst 8510 CSR. This feature is similar to the IOS committed access rate (CAR) feature. You can deploy rate limiting on your switch router to ensure that a packet, or data source, adheres to a stipulated contract, and to determine the QoS for a packet.

Rate limiting can be applied to individual interfaces. When an interface is configured with this feature, the traffic rate will be monitored by the Ethernet processor interface ucode to verify conformity. Non-conforming traffic is dropped, conforming traffic passes through without any changes.

Features Supported

The following features are supported for rate limiting on the Catalyst 8500 switch router:

- This feature is supported on the following interface modules:
  - Eight-Port 10/100BASE-T Fast Ethernet Interface Modules
  - 16-Port 10/100BASE-T Fast Ethernet Interface Modules
  - Eight-Port 100BASE-FX Fast Ethernet Interface Modules
  - 16-port 100BASE-FX Fast Ethernet Interface Modules
- This feature can be applied on a per-physical-port basis.
- This feature is available for input traffic and output traffic.

Restrictions

Restrictions for rate limiting on the Catalyst 8500 switch router include the following:

- This feature is not supported on the LightStream 1010.
- IPX and rate limiting cannot be configured at the same time. If rate limiting is configured on an interface, IPX will be automatically disabled on that interface. In addition, IPX will be automatically disabled on any of the three other interfaces which are controlled by the same hardware micro-controller as the configured interface. For example, if rate limiting is configured on Fast Ethernet slot 0, IPX will not work on slots 0, 1, 2, and 3.
- The QoS mapping ratio might be disrupted by the rate limiting configuration.
- Due to additional processing, when rate limiting is enabled, switching might not be at wire speed.

Note Broadcast packets, dropped ACL packets, packets dropped due to expiration of the designed Time To Live, and bad CRC packets are included in the rate limit calculation. This might cause a problem if the policed port is not part of a point-to-point connection and is connected via a hub rather than a layer 2 switch.

Configuring Rate Limiting

Enter the following command in interface configuration mode to configure rate limiting on your switch router:

Command	Purpose
rate-limit {**input** | **output**} *rate burst*	Configures rate limiting on an interface.

For more detailed configuration information, refer to the "Policing and Shaping Overview" section of the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Example

The following is an example of how to configure rate limiting on your switch router:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z
Router(config)# interface f0/0/0
Router(config-if)# rate-limit input 1000000 20000
Router(config-if)# rate-limit output 100000 30000
Router(config-if)# exit
```

Traffic Shaping

Traffic shaping allows you to shape output traffic (egress traffic) on a per-physical port basis. Ucode monitors output traffic to verify that it conforms to the rate configured on the switch router. When excess traffic comes into the switch, the output side of the processor interface applies back pressure and queues the excess traffic in the switch fabric. If the switch fabric queues overflow, the traffic is dropped. This feature is similar to the IOS GTS feature.

Features

Traffic shaping on the Catalyst 8500 switch router includes the following features:

- This feature is supported on the following interface modules:
  - Eight-Port 10/100BASE-T Fast Ethernet Interface Modules
  - 16-Port 10/100BASE-T Fast Ethernet Interface Modules
  - Eight-Port 100BASE-FX Fast Ethernet Interface Modules
  - 16-port 100BASE-FX Fast Ethernet Interface Modules
- Per-physical port traffic shaping
- Back pressure and traffic queues
- Egress traffic traffic shaping

Restrictions

Restrictions for traffic shaping on the Catalyst 8500 switch router include the following:

- This feature is not supported on the LightStream 1010.
- IPX and traffic shaping cannot be configured at the same time. If traffic shaping is configured on an interface, IPX will be automatically disabled on that interface. In addition, IPX will be automatically disabled on any of the three other interfaces which are controlled by same hardware micro-controller as the configured interface. For example, if traffic shaping is configured on Fast Ethernet slot 0, IPX will not work on slots 0, 1, 2, and 3.
- The QoS mapping ratio might be disrupted by the rate limiting configuration.
- This feature is not available for ingress traffic.

Configuring Traffic Shaping

Enter the following command in interface configuration mode to configure traffic shaping on your switch router:

Command	Purpose
traffic-shape rate {*target-bit-rate* | *bit per interval* }	Configures traffic shaping on a port.

Example

The following is an example of how to configure rate limiting on your switch router:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z
Router(config)# interface f0/0/0
Router(config-if)# traffic-shape rate 1000000 20000
Router(config-if)# exit
```

Displaying the Configurations

To display the rate limiting and traffic shaping configurations, enter the following commands in Privileged EXEC mode:

Command	Purpose
show epc port-qos	Displays the port configurations.
show epc port qos interface	Displays the QoS configuration.
show epc port-qos interface *card/subcard/port* **out**	Displays the output for port QoS parameters for a particular interface.

Example

The following is an example of how to display the port configuration on your switch router:

```
Router# show epc port-qos
Interface Type Input/ Target-Rate Burst-Size
Output (bits/sec) (bytes)
---------------------------------------------------------------------
FastEthernet0/0/0 Rate-Limit Input 1000000 20000
Rate-Limit Output 100000 30000
```

Example

The following is an example of how to display the QoS configuration on your switch router:

```
Router# show epc port-qos
Interface           Type            Input/ Target-Rate    Burst-Size
                                    Output  (bits/sec)       (bytes)
---------------------------------------------------------------------
FastEthernet9/0/3    Rate-Limit      Input     10000000         64000
                     Rate-Limit      Output    10000000         64000
```

Example

The following is an example of how to display the port QoS input parameters for an interface:

```
Router# show epc port-qos interface f9/0/3 in
Input Port QoS Parameters:
Current number of tokens                    (tokens):  65352
Configured burst size                    (burstsize):  65352
Token update interval (ticks)                (time1):   7789
Tokens added per interval         (tokens_in_time1):   1556
Time to fill bucket (ticks)     (time_to_fill_burst): 327138
```

Example

The following is an example of how to display the QoS output parameters for an interface:

```
Router# show epc port-qos interface f9/0/3 out
Output Port QoS Parameters:
Current number of tokens                    (tokens):  65352
Configured burst size                    (burstsize):  65352
Token update interval (ticks)                (time1):   7789
Tokens added per interval          (tokens_in_time1):   1556
Time to fill bucket (ticks)     (time_to_fill_burst): 327138
```

CHAPTER 25

Configuring ATM Router Module Interfaces

This chapter describes steps required to configure the ATM router module on the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers, and the enhanced ATM router module for the Catalyst 8540 MSR. The ATM router module allows you to integrate Layer 3 switching with ATM switching on the same ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication. For hardware installation and cabling instructions, refer to the *ATM and Layer 3 Module Installation Guide*.

Note The LightStream 1010 system software image does not include support for the ATM router module or Layer 3 features. You can download the Catalyst 8510 MSR image to a LightStream 1010 ATM switch router with a multiservice ATM switch processor installed.

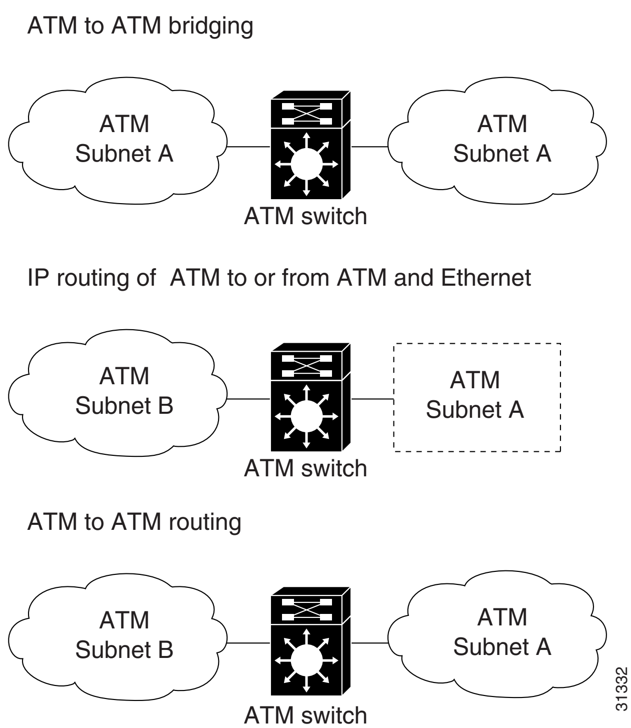
This chapter includes the following sections:

Overview of the ATM Router Module

The ATM router module allows you to integrate Layer 3 routing and ATM switching within a single chassis. When you install the ATM router module, you no longer need to choose either Layer 3 or ATM technology, as is frequently the case with enterprise, campus, and MAN applications.

The ATM router module can perform one or more of the functions described in Figure 25-1.

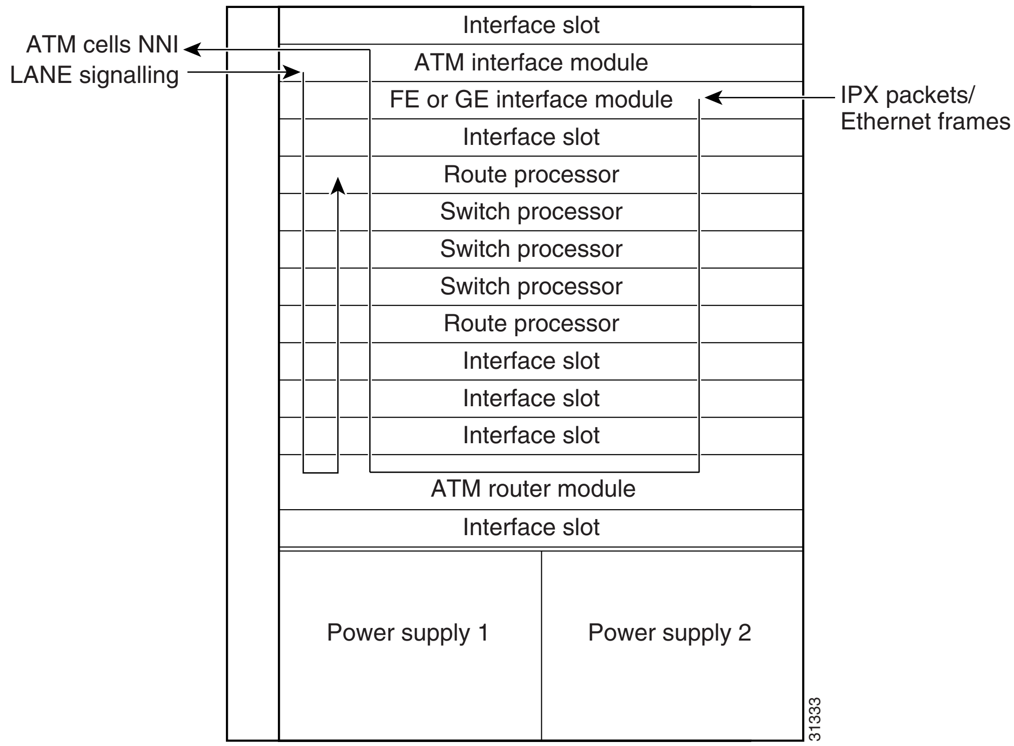
Figure 25-1 ATM Router Module Routing and Bridging Functions



The ATM router module receives Address Resolution Protocol (ARP) messages and route broadcasts from connected ATM peers and sends the appropriate control information to the route processor. On the ATM side, the ATM router module connects to the switching fabric as would any other interface module.

On the Catalyst 8540 MSR, the ATM router module supports LANE clients (LECs), but not LANE servers (LES, LECS, and BUS). It separates the control and data path so that all LANE control messages are handled by the route processor, and data messages are switched on the ATM router module port, as shown in Figure 25-2. The LEC is configured on the ATM router module interface, but control message traffic is sent to the route processor by the ATM router module. The ATM router module sends all ATM data traffic to the appropriate VCs.

Figure 25-2 ATM Router Module Traffic Flow (Catalyst 8540 MSR)



Catalyst 8540 MSR Enhanced ATM Router Module Features

The Catalyst 8540 MSR enhanced ATM router module offers the following benefits:

- Interoperates with all of the Layer 3 switching interface modules available for the Catalyst 8540 CSR chassis. For more information on the Catalyst 8540 CSR Layer 3 interface modules, refer to the *ATM and Layer 3 Module Installation Guide*.
- Provides an integrated high performance link between ATM and Layer 3 cards. The ATM router module provides an aggregate switching capacity of 2 Gbps between ATM and Layer 3 ports (2 x 1-Gbps interfaces per module). Data transfers to the switch core at the rate of 1 Gbps.
- Simplifies management.
- Hot-swappable.
- Occupies only one slot in the chassis.
- Supports multiprotocol encapsulation over ATM (RFC 1483) switched virtual connections (SVCs), soft permanent virtual circuits (PVCs) and permanent PVCs with either ATM adaptation layer 5 (AAL5) Subnetwork Access Protocol (SNAP) or AAL5 MUX encapsulation.
- Supports classical ATM over IP (RFC 1577) SVCs and PVCs.
- Standard and extended access control list (ACL) support for IP, and standard ACL support for IPX.

  For information configuring on IP ACLs, see Chapter 12, “Using Access Control,” and refer to the “Configuring IP Services” chapter in the *Cisco IOS IP and IP Routing Configuration Guide.* For information configuring on IPX ACLs, refer to the “Configuring Novell IPX” chapter in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*.

- IP fragmentation support.
- IP 6-path load balancing support.
- Supports OAM-based PVC management.
- Supports integrated routing and bridging (IRB).
- Supports LANE clients (LECs).
- Supports Soft PVCs.
- Supports VBR.
- Supports Shaped Tunnels.
- Supports a maximum of 8192 VCs.
- LECs and RFC 1483 PVCs can both be configured on different subinterfaces of the same main interface.

Note Catalyst 8540 MSR enhanced ATM router module supports LANE clients from IOS release 12.1(20)EB.

The ATM router module has no external interfaces. All traffic is sent and received through internal interfaces to the switching fabric. The Catalyst 8540 MSR enhanced ATM router module has two internal ports.

Catalyst 8540 MSR ATM Router Module Features

The Catalyst 8540 MSR ATM router module offers the following benefits:

- Interoperates with all of the Layer 3 switching interface modules available for the Catalyst 8540 CSR chassis. For more information on the Catalyst 8540 CSR Layer 3 interface modules, refer to the *ATM and Layer 3 Module Installation Guide*.
- Provides an integrated high performance link between ATM and Layer 3 cards. The ATM router module provides an aggregate switching capacity of 2 Gbps between ATM and Layer 3 ports (2 x 1-Gbps interfaces per module). Data transfers to the switch core at the rate of 1 Gbps.
- Simplifies management.
- Hot-swappable.
- Occupies only one slot in the chassis.
- Supports LANE clients (LECs).
- Supports RFC 1483 SVCs and PVCs with AAL5 SNAP encapsulation.
- Supports RFC 1577 SVCs and PVCs.
- Supports Soft PVCs
- Supports VBR
- Supports Shaped Tunnels
- Supports OAM-based PVC management.
- Supports BVI.
- Supports IRB.

The ATM router module has no external interfaces. All traffic is sent and received through internal interfaces to the switching fabric. The Catalyst 8540 MSR enhanced ATM router module has two internal ports.

Catalyst 8510 MSR and LightStream 1010 ATM Router Module Features

The Catalyst 8510 MSR and LightStream 1010 ATM router module offers the following benefits:

- Interoperates with all of the Layer 3 switching interface modules available for the Catalyst 8510 CSR chassis. For more information on the Catalyst 8510 CSR Layer 3 interface modules, refer to the *ATM and Layer 3 Module Installation Guide*.
- Provides an integrated high performance link between ATM and Layer 3 cards. The ATM router module provides a switching capacity of 1 Gbps between ATM and Layer 3 ports. Data transfers to the switch core at the rate of 1 Gbps.
- Simplifies management.
- Hot-swappable.
- Occupies only one slot in the chassis.
- Supports RFC 1483 SVCs and PVCs with AAL5 SNAP encapsulation.
- Supports RFC 1577 SVCs and PVCs.
- Supports OAM-based PVC management.
- Supports BVI.
- Supports IRB.
- Supports VBR.

The ATM router module has no external interfaces. All traffic is sent and received through internal interfaces to the switching fabric. The Catalyst 8510 MSR and LightStream 1010 ATM router module has one internal port.

Hardware and Software Restrictions of the ATM Router Module

Hardware Restrictions

The following hardware restrictions apply to the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM router modules, and the Catalyst 8540 MSR enhanced ATM router modules:

- You can install the ATM router module in any slot except a route processor slot, and, in the case of the Catalyst 8540 MSR, a switch processor slot.
- The ATM router module is only supported on LightStream 1010 ATM switches with multiservice ATM switch route processor with FC-PFQ and the Catalyst 8510 MSR system software image.
- You can install up to two ATM router modules per chassis.
- When you hot swap an ATM router module, wait one minute after removing the module before inserting a new module.

Note The ATM router module is only supported on ATM switches which have multiservice ATM switch processor installed.

Catalyst 8540 MSR Enhanced ATM Router Module Software Restrictions

The following software restrictions apply to the Catalyst 8540 MSR enhanced ATM router module:

- Use tag switching functionality with caution. Do not distribute routes learned through tag switching to Fast Ethernet (FE) or Gigabit Ethernet (GE), or vice versa. Otherwise, you might have unreachable route destinations.
- The ATM router module does not initialize if it replaces an ATM port adapter or interface module when hierarchical VP tunnels are globally enabled. Reboot the switch to initialize the ATM router module.
- IP multicast is only supported over 1483 LLC/SNAP encapsulated PVCs.
- ATM Director does not support any PVC commands.
- Even though each enhanced ATM Router Module interface supports a maximum of 8192 VCs, only 7544 to 7644 external VCs can be configured. Internal VCs use the remaining VCs.
- Do not install an ATM router module in a slot pair where hierarchical VP tunnels are configured. Slot pairs 0 and 1, 2 and 3, 9 and 10, and 11 and 12 use the same switching modules for scheduling. For example, do not install an ATM router module in slot 10 when hierarchical VP tunnels are configured on slot 9. For more information on hierarchical VP tunneling restrictions, see Chapter 7, "Configuring Virtual Connections."

The Catalyst 8540 MSR enhanced ATM router modules do not support the following features:

- Tag-edged router functionality is not supported.
- Fast Simple Server Redundancy Protocol (FSSRP) is not supported.
- Bridging for multiplexing device encapsulation is not supported.
- Protocol Independent Multicast (PIM) IP multipoint signalling is not supported.
- PIM nonbroadcast multiaccess (NBMA) is not supported.
- PIM over ATM multipoint signalling is not supported.
- Translation from IP quality of service (QoS) to ATM QoS is not supported.
- Resource Reservation Protocol (RSVP) to ATM SVC is not supported.
- PVC management using ILMI is not supported.
- IP multicast over RFC 1483 SVCs is not supported.
- Access lists for ATM to ATM routing is not supported.
- Half-bridge devices are not supported.
- Layer 2 ACLs are not supported.
- Token Ring LANE is not supported.
- LANE with IPX is not supported.

Catalyst 8540 MSR ATM Router Module Software Restrictions

The following software restrictions apply to the Catalyst 8540 MSR ATM router module:

- Use tag switching functionality with caution. Do not distribute routes learned through tag switching to FE or GE, or vice versa. Otherwise, you might have unreachable route destinations.
- The ATM router module does not initialize if it replaces an ATM port adapter or interface module when hierarchical VP tunnels are globally enabled. Reboot the switch to initialize the ATM router module.
- ATM Director does not support any PVC commands.
- Only LANE clients or RFC 1483, not both, can be configured on an ATM router module interface.
- RFC 1483 on the ATM router module supports only AAL5 SNAP encapsulation.
- Even though each ATM router module interface supports a maximum of 2048 VCs, only 1400 to 1500 external VCs can be configured. Internal VCs use up the rest.
- IP multicast is only supported over 1483 LLC/SNAP encapsulated PVCs.
- You can have a maximum of 64 LECs per chassis.
- Do not install an ATM router module in a slot pair where hierarchical VP tunnels are configured. Slot pairs 0 and 1, 2 and 3, 9 and 10, and 11 and 12 use the same switching modules for scheduling. For example, do not install an ATM router module in slot 10 when hierarchical VP tunnels are configured on slot 9. For more information on hierarchical VP tunneling restrictions, see Chapter 7, "Configuring Virtual Connections."
- Token Ring LANE is not supported.

The Catalyst 8540 MSR ATM router modules do not support the following features:

- Tag-edged router functionality is not supported.
- Fast Simple Server Redundancy Protocol (SSRP) is not supported.
- Bridging for multiplexing device encapsulation is not supported.
- PIM IP multipoint signalling is not supported.
- PIM NBMA is not supported.
- PIM over ATM multipoint signalling is not supported.
- Translation from IP QoS to ATM QoS is not supported.
- RSVP to ATM SVC is not supported.
- PVC management using ILMI is not supported.
- Access lists for ATM to ATM routing is not supported.
- Half-bridge devices are not supported.
- RFC 1483 MUX encapsulation is not supported.
- IP multicast over RFC 1483 SVCs are not supported.
- ACLs for IP, and standard ACLs for IPX is not supported.
- IP fragmentation is not supported.
- IP 6-path load balancing is not supported.

Catalyst 8510 MSR ATM Router Module Software Restrictions

The following software restrictions apply to the Catalyst 8510 MSR enhanced ATM router module:

- Use tag switching functionality with caution. Do not distribute routes learned through tag switching to FE or GE, or vice versa. Otherwise, you might have unreachable route destinations.
- The ATM router module does not initialize if it replaces an ATM port adapter or interface module when hierarchical VP tunnels are globally enabled. Reboot the switch to initialize the ATM router module.
- ATM Director does not support any PVC commands.
- RFC 1483 on the ATM router module supports only AAL5 SNAP encapsulation.
- Even though each ATM router module interface supports a maximum of 2048 VCs, only 1400 to 1500 external VCs can be configured. Internal VCs use up the rest.
- Do not install an ATM router module in a slot pair where hierarchical VP tunnels are configured. Slot pair 0 and 1 and slot pair 3 and 4 use the same switching modules for scheduling. For example, do not install an ATM router module in slot 1 when hierarchical VP tunnels are configured on slot 0. For more information on hierarchical VP tunneling restrictions, see Chapter 7, "Configuring Virtual Connections."
- RFC 1577 SVCs
- LANE clients are not supported.
- Only UBR PVCs are supported.
- IP multicast is only supported over 1483 LLC/SNAP encapsulated PVCs.

The Catalyst 8510 MSR and LightStream 1010 ATM router modules do not support the following features:

- Tag-edged router functionality is not supported.
- SSRP is not supported.
- Bridging for multiplexing device encapsulation is not supported.
- Protocol Independent Multicast (PIM) IP multipoint signalling is not supported.
- PIM nonbroadcast multiaccess (NBMA) is not supported.
- PIM over ATM multipoint signalling is not supported.
- Translation from IP quality of service (QoS) to ATM QoS is not supported.
- Resource Reservation Protocol (RSVP) to ATM SVC is not supported.
- PVC management using ILMI is not supported.
- Access lists for ATM to ATM routing is not supported.
- Half-bridge devices are not supported.
- RFC 1483 MUX encapsulation
- IP multicast over RFC 1483 SVCs are not supported.
- ACLs for IP, and standard ACLs for IPX is not supported.

- IP fragmentation.
- IP 6-path load balancing.

Note The ATM router module is only supported on ATM switches which have a multiservice ATM switch processor installed.

Note The LightStream 1010 system software image does not include support for the ATM router module or Layer 3 features. You can download this image to a LightStream 1010 ATM switch router with a multiservice ATM switch processor installed.

Configuring ATM Router Module Interfaces

The you can configure the following features directly on the ATM router module interfaces:

- Maximum virtual channel identifier (VCI) bits
- Maximum Transmission Units (MTUs) (enhanced Catalyst 8540 MSR)
- LANE clients (Catalyst 8540 MSR)
- RFC 1483
- Classical IP over ATM (RFC 1577)
- Bridging
- IP multicast

Note This document describes how to configure ATM software features combined with Layer 3 features only. For more detailed information on how to configure the Layer 3 modules that interoperate with the ATM router module in the Catalyst 8540 MSR chassis, refer to the *Layer 3 Switching Software Feature and Configuration Guide*, which is available on the Documentation CD-ROM that came with your ATM switch router, online at Cisco.com, or when ordered separately as a hard copy document.

Note ATM router modules have internal interfaces, but no external ports. Use the **interface atm** *card/subcard/port* command to specify these interfaces.

Note Virtual path identifier (VPI) 2 is reserved for ATM router module interfaces, which allows up to 2048 external VCs on each ATM router module interface. Using VPI 0 would have allowed less than 1024 external VCs on an ATM router module interface because the ATM router module external VCs would have been forced to share the VC space within VPI 0 with the internal PVCs.

Even though each ATM router module interface supports a maximum of 2048 VCs, only 1400 to 1500 external VCs can be configured. Internal VCs use up the rest.

Default ATM Router Module Interface Configuration Without Autoconfiguration

If ILMI is disabled or if the connecting end node does not support ILMI, the following defaults are assigned to all ATM router module interfaces:

- ATM interface type = UNI
- UNI version = 3.0
- Maximum VCI bits = 11
- MTU size = 1500 bytes
- ATM interface side = network
- ATM UNI type = private

Note Only Catalyst 8540 MSR enhanced ATM router module interfaces support IP unicast and IP multicast fragmentation. For IP unicast fragmentation, the packet must ingress on an enhanced ATM router module interface and egress on any interface. For IP multicast fragmentation, IP multicast data packets greater than 1500 bytes are fragmented to 1500 bytes on the ingress enhanced ATM router module interface before being switched to other members in the multicast group. All the members in the multicast group must have an MTU equal to or greater than 1500 bytes.

Configuring LECs on ATM Router Module Interfaces (Catalyst 8540 MSR)

The procedures for configuring LANE clients (LECs) on the ATM router module or enhanced ATM router module are the same as for the configuration of LECs on the route processor, with one exception: To specify an ATM router module interface, rather than the route processor interface, use the **interface atm** *card***/***subcard***/***port* command. On the route processor, you would use the **interface atm 0** command.

Note To route traffic between an emulated LAN and a Fast Ethernet (FE) or Gigabit Ethernet (GE) interface, you must configure the LEC on either the ATM router module or enhanced ATM router module interface rather than a route processor interface.

Note With the enhanced ATM router module, both LEC and RFC 1483 PVCs configuration is supported on the same enhanced ATM router module interface. For example, LEC and RFC 1483 PVCs configuration is allowed on different subinterfaces of the same main interface of the enhanced ATM router module port.

Configuring both LEC and RFC 1483 PVCs on the same interface was not supported on the earlier version of the ATM router module. Either LEC or RFC 1483 PVCs could be configured on the subinterfaces of an ATM router module main interface. For both LECs and RFC 1483 PVCs to operate on the same ATM router module, you must configure LECs on the subinterfaces of one main interface and RFC 1483 PVCs on the subinterfaces of the other main interface.

To configure a LEC on an ATM router module interface, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port.subinterface#* **multipoint** Switch(config-subif)#	Creates the ATM router module point-to-multipoint subinterface and enters subinterface mode. **Note** The ATM router module only supports point-to-multipoint subinterfaces.
Step 2	Switch(config-subif)# **ip address** *ip-address mask*	Provides a protocol address and subnet mask for the client on this subinterface.
Step 3	Switch(config-subif)# **lane client ethernet** *elan-name*	Enables a LANE client for an emulated LAN.

Example

The following example shows how to configure two LECs on an ATM router module interface:

```
Switch# configure terminal
Switch(config)# interface atm 1/0/0.4 multipoint
Switch(config-subif)# ip address 40.0.0.1 255.0.0.0
Switch(config-subif)# lane client ethernet VLAN4
Switch(config-subif)# exit
Switch(config)# interface atm 1/0/0.5 multipoint
Switch(config-subif)# ip address 50.0.0.1 255.0.0.0
Switch(config-subif)# lane client ethernet VLAN5
Switch(config-subif)# exit
Switch(config)# router ospf 1
Switch(config-router)# network 40.0.0.0 0.255.255.255 area 0
Switch(config-router)# network 50.0.0.0 0.255.255.255 area 0
```

For more information on configuring LECs on ATM router module interfaces, see Chapter 14, "Configuring LAN Emulation." For a detailed description of LANE and its components, refer to *Cisco IOS Switching Services Configuration Guide: Virtual LANs*.

LEC Configuration Examples

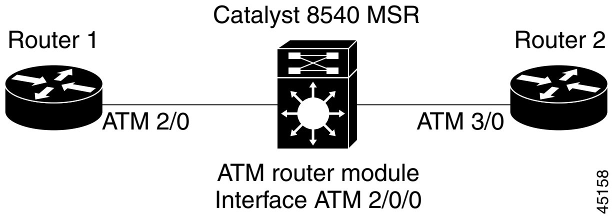
The examples in this section show how to configure LANE clients (LECs) on networks with two routers and one Catalyst 8540 MSR. For detailed information on configuring the LANE server (LES), LANE configuration server (LECS), and broadcast-and-unknown server (BUS), see Chapter 14, "Configuring LAN Emulation."

Caution For performance reasons, avoid configuring the LANE server components on ATM switch routers. Instead, configure the LANE server components on a router such as a Cisco 7500 series router or a Catalyst 5500 router with a LANE module installed.

LANE Routing Over ATM

The following example shows how to configure LANE routing over ATM using the ATM router module. Figure 25-3 shows an example of a network for LANE routing over ATM.

Figure 25-3 Example Network for LANE Routing over ATM



Router 1 ATM Interface

```
Router1# configure terminal
Router1(config)# interface atm 2/0
Router1(config-if)# ip address 1.0.0.1 255.0.0.0
Router1(config-if)# atm pvc 1 0 5 qsaal
Router1(config-if)# atm pvc 2 0 16 ilmi
Router1(config-if)# lane client ethernet happy
Router1(config-if)# end
Router1#
```

ATM Switch Router ATM Router Module Interface

```
Switch# configure terminal
Switch(config)# interface atm 2/0/0.1 multipoint
Switch(config-if)# ip address 1.0.0.2 255.0.0.0
Switch(config-if)# lane client ethernet happy
Switch(config)# interface atm 2/0/0.2 multipoint
Switch(config-if)# ip address 2.0.0.1 255.0.0.0
Switch(config-if)# lane client ethernet BACKBONE
Switch(config-if)# end
Switch#
```

Router 2 ATM Interface

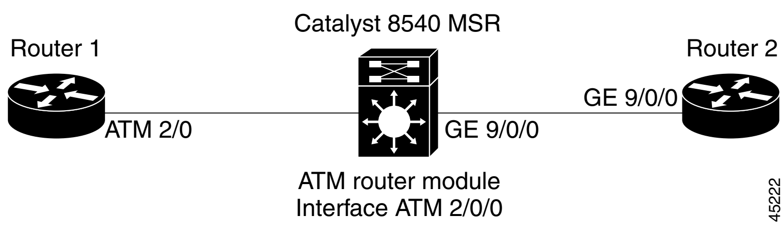
```
Router2# configure terminal
Router2(config)# interface atm 3/0
Router2(config-if)# ip address 2.0.0.2 255.0.0.0
Router2(config-if)# no ip mroute-cache
Router2(config-if)# atm pvc 1 0 5 qsaal
Router2(config-if)# atm pvc 2 0 16 ilmi
Router2(config-if)# no atm ilmi-keepalive
Router2(config-if)# lane client ethernet BACKBONE
Router2(config-if)# end
Router2#
```

For detailed information on configuring LANE clients (LECs), see Chapter 14, "Configuring LAN Emulation."

LANE Routing from ATM to Ethernet

The following example shows how to configure LANE routing from ATM to Ethernet using the ATM router module. Figure 25-4 shows an example of a LANE network for LANE routing from ATM to Ethernet.

Figure 25-4 Example Network for LANE Routing from ATM to Ethernet



Router 1 ATM Interface

```
Router1# configure terminal
Router1(config)# interface atm 2/0
Router1(config-if)# ip address 1.0.0.1 255.0.0.0
Router1(config-if)# atm pvc 1 0 5 qsaal
Router1(config-if)# atm pvc 2 0 16 ilmi
Router1(config-if)# lane client ethernet happy
Router1(config-if)# end
Router1#
```

ATM Switch Router ATM Router Module Interface

```
Switch# configure terminal
Switch(config)# interface atm 2/0/0.1 multipoint
Switch(config-if)# ip address 1.0.0.2 255.0.0.0
Switch(config-if)# lane client ethernet happy
Switch(config-if)# end
Switch#
```

ATM Switch Router Ethernet Interface

```
Switch# configure terminal
Switch(config)# interface gigabitethernet 9/0/0
Switch(config-if)# ip address 129.1.0.1 255.255.255.0
Switch(config-if)# no ip directed-broadcast
Switch(config-if)# end
Switch#
```

Router 2 Ethernet Interface

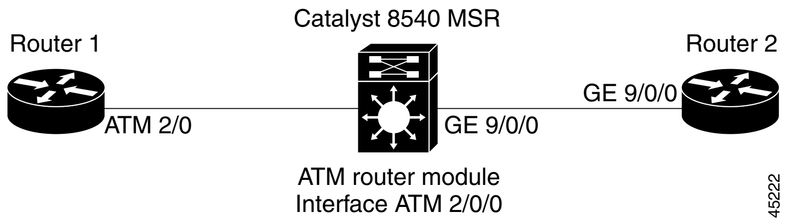
```
Router2# configure terminal
Router2(config)# interface gigabitethernet 9/0/0
Router2(config-if)# ip address 129.1.0.2 255.255.255.0
Router2(config-if)# no ip directed-broadcast
Router2(config-if)# end
Router2#
```

Configure the desired network routing protocol, such as RIP, OSPF, or EIGRP, on Ethernet interfaces. For more information on configuring networking protocols and routing, refer to the *Layer 3 Software Configuration Guide*.

LANE Bridging Between ATM and Ethernet

The following example show how to configure LANE bridging between ATM and Ethernet using the ATM router module. Figure 25-5 shows an example of a network for LANE bridging between ATM and Ethernet.

Figure 25-5 Example Network for LANE Bridging Between ATM and Ethernet



Router 1 ATM Interface

```
Router1# configure terminal
Router1(config)# interface atm 2/0
Router1(config-if)# atm pvc 1 0 5 qsaal
Router1(config-if)# atm pvc 2 0 16 ilmi
Router1(config-if)# lane client ethernet happy
Router1(config-if)# bridge-group 1
Router1(config-if)# end
Router1#
```

Router 1 Bridge Interface

```
Router1# configure terminal
Router1(config)# interface BVI1
Router1(config-if)# ip address 130.2.3.1 255.255.255.0
Router1(config-if)# exit
Router1(config)# bridge 1 protocol ieee
Router1(config)# bridge 1 route ip
Router1(config)# bridge irb
Router1(config)# end
Router1#
```

ATM Switch Router ATM Router Module Interface

```
Switch# configure terminal
Switch(config)# interface atm 2/0/0.1 multipoint
Switch(config-if)# lane client ethernet happy
Switch(config-if)# bridge-group 1
Switch(config-if)# exit
Switch(config)# bridge 1 protocol ieee
Switch(config)# end
Switch#
```

ATM Switch Router Ethernet Interface

```
Switch# configure terminal
Switch(config)# interface gigabitethernet9/0/0
Switch(config-if)# bridge-group 1
Switch(config-if)# end
Switch#
```

Router 2 Ethernet Interface

```
Router2# configure terminal
Router2(config)# interface ethernet 9/0/0
Router2(config-if)# bridge-group 1
Router2(config-if)# end
Router2#
```

Router 2 Bridge Interface

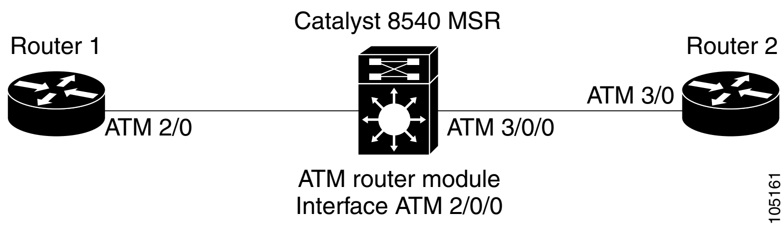
```
Router2# configure terminal
Router2(config)# interface BVI1
Router2(config-if)# ip address 130.2.3.4 255.255.255.0
Router2(config-if)# exit
Router2(config)# bridge 1 protocol ieee
Router2(config)# bridge 1 route ip
Router2(config)# bridge irb
Router2(config)# end
Router2#
```

For more information on configuring bridging, refer to the *Layer 3 Software Configuration Guide*.

Configuring LECs and 1483 PVCs on Enhanced ATM Router Module Interfaces

The following example shows how to configure LECs and 1483 PVCs on enhanced ATM router module interfaces. Figure 25-6 shows an example of LECs and 1483 PVCs on enhanced ATM router module interfaces.

Figure 25-6 Example Network for LECs and 1483 PVCs on Enhanced ATM Router Module Interfaces



Router 1 ATM Interface

```
Router1# configure terminal
Router1(config)# interface atm 2/0
Router1(config-if)# ip address 1.0.0.1 255.0.0.0
Router1(config-if)# atm pvc 1 0 5 qsaal
Router1(config-if)# atm pvc 2 0 16 ilmi
Router1(config-if)# lane client ethernet happy
Router1(config-if)# end
Router1#
```

ATM Switch Router ATM Router Module Interface

```
Switch# configure terminal
Switch(config)# interface atm 2/0/0.1 multipoint
Switch(config-if)# ip address 1.0.0.2 255.0.0.0
Switch(config-if)# lane client ethernet happy
Switch(config)# interface atm 2/0/0.2 multipoint
Switch(config-if)# ip address 2.0.0.1 255.0.0.0
Switch(config-subif)# map-group net1011
Switch(config-subif)# atm pvc 2 101 interface atm 3/0/0 0 101 encap aal5snap
Switch(config-subif)# exit
```

```
Switch(config)# map-list net1011
Switch(config-map-list)# ip 2.0.0.2 atm-vc 101
Switch(config-map-list)# end
Switch#
```

Router 2 ATM Interface

```
Router2# configure terminal
Router2(config)# interface atm 3/0
Router2(config-if)# ip address 2.0.0.2 255.0.0.0
Router2(config-if)# no ip mroute-cache
Router2(config-if)# atm pvc 1 0 5 qsaal
Router2(config-if)# atm pvc 2 0 16 ilmi
Router2(config-if)# map-group net1011
Router2(config-if)# atm pvc 2 0 101 aal5snap
Router2(config-if)# exit
Router2(config)# map-list net1011
Router2(config-map-list)# ip 2.0.0.1 atm-vc 101
Router2(config-map-list)# end
Router2#
```

Confirming the LEC Configuration

To confirm the LEC configuration on the ATM switch router, use the following EXEC commands:

Command	Purpose
show lane [**interface atm** *card*/*subcard*/*port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-virtual channel connection LANE information for all the LANE components and emulated LANs configured on an interface or any of its subinterfaces.
show lane client [**interface atm** *card*/*subcard*/*port*[**.***subinterface#*] | **name** *elan-name*] [**brief**]	Displays the global and per-VCC LANE information for all LANE clients configured on any subinterface or emulated LAN.
show lane config [**interface atm** *card*/*subcard*/*port*[**.***subinterface#*]]	Displays the global and per-VCC LANE information for the configuration server configured on any interface.

Configuring Jumbo Frames

Jumbo frames are frames larger than the standard Ethernet frame size, which is 1518 bytes (including Layer 2 (L2) header and Frame Check Sequence (FCS)). You can use the **mtu** command in interface configuration mode to configure a non-default value for the frame.

Note For enhanced Gigabit Ethernet interface modules, MTU on the subinterface should be less than or equal to the MTU on the main interface.

Using a consistent and max-sized MTU across multiple interfaces in your network reduces or eliminates fragmentation. Larger MTUs can enhance TCP performance by eliminating fragmentation, so applications such as Network File System (NFS) can take greater advantage of their large native MTUs of around 8 KB.

Jumbo frame support is only available on the following enhanced ATM router module and the two-port enhanced Gigabit Ethernet modules:

- C8540-ARM2—enhanced ATM Router Module with 64K, 128K, and 256K routing table entries
- C85EGE-2X-16K—two-port enhanced Gigabit Ethernet module with 16K routing table entries
- C85EGE-2X-64K—two-port enhanced Gigabit Ethernet module with 64K routing table entries
- C85EGE-2X-256K—two-port enhanced Gigabit Ethernet module with 64K routing table entries

Note Only these hardware revisions have an ASIC that supports changing the MTU value.

To configure the jumbo frames perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies the enhanced ATM router module or enhanced Gigabit Ethernet interface to configure.
Step 2	Switch(config-if)# **mtu** *bytes*	Adjust the maximum packet size or MTU size.

Example

The following is an example of how to configure the MTU on the enhanced ATM router module interface to 9218 bytes:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z
Router(config)# interface atm 12/0/0
Router(config-if)# mtu 9218
```

Displaying the Interface MTU Configuration

To show the interface MTU configuration, use the following EXEC commands:

Command	Purpose
show atm interface [**atm** *card/subcard/port*[**.***vpt#*]]	Shows the ATM interface configuration.

Examples

In the following example, the **show interface atm** command output shows that the MTU configuration was changed on the interface ATM 12/0/0:

```
Switch# show interface atm 12/0/0
ATM12/0/0 is up, line protocol is up
  Hardware is arm2_port, address is 0090.2141.b077 (bia 0090.2141.b077)
  SVC idle disconnect time: 300 seconds
  MTU 9218 bytes, sub MTU 17976, BW 1000000 Kbit, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
```

Configuring Multiprotocol Encapsulation over ATM

This section describes how to configure multiprotocol encapsulation over ATM, as defined in RFC 1483, on the ATM router module.

The primary use of multiprotocol encapsulation over ATM, also know as RFC 1483, is carrying multiple Layer 3 and bridged frames over ATM. RFC 1483 traffic is routed through an ATM router module interface using static map lists. Static map lists provide an alternative to using the ATM Address Resolution Protocol (ARP) and ATM Inverse ARP (InARP) mechanisms. For more information on static map lists, see Chapter 13, "Configuring IP over ATM."

For a detailed description of multiprotocol encapsulation over ATM, refer to the *Guide to ATM Technology*.

Note Traffic shaping and policing are not supported on the ATM router module interfaces; for traffic shaping and policing on ATM connections, use VP tunnels. For more information on VP tunnels, see Chapter 7, "Configuring Virtual Connections."

To configure multiprotocol encapsulation over ATM on the ATM router module interface, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port.subinterface#* **multipoint** Switch(config-subif)#	Creates the ATM router module point-to-multipoint subinterface and enters subinterface mode. **Note** The ATM router module only supports point-to-multipoint subinterfaces.
Step 2	Switch(config-subif)# **ip address** *ip-address mask*	Enters the IP address and subnet mask associated with this interface.
Step 3	Switch(config-subif)# **map-group** *name*	Enters the map group name associated with this PVC.
Step 4	Switch(config-subif)# **atm pvc 2** *vci-a* [**upc** *upc*] [**pd** *pd*] [**rx-cttr** *index*] [**tx-cttr** *index*] **interface atm** *card/subcard/port*[.*vpt#*] *vpi-b vci-b* [**upc** *upc*] **encap** {**aal5mux**[1] | **aal5snap**}	Configures the PVC. **Note** The VPI number on the ATM router module interface must be 2.
Step 5	Switch(config-subif)# **exit** Switch(config)#	Returns to global configuration mode.
Step 6	Switch(config)# **map-list** *name* Switch(config-map-list)#	Creates a map list by naming it, and enters map-list configuration mode.
Step 7	Switch(config-map-list)# **ip** *ip-address* {**atm-nsap** *address* | **atm-vc** *vci*} [**broadcast**]	Associates a protocol and address with a specific virtual circuit.

1. Only the Catalyst 8540 MSR enhanced ATM router module supports AAL5 MUX encapsulation.

Example

The following example shows how to configure RFC 1483 on an ATM router module interface, beginning in global configuration mode:

```
Switch(config)# interface atm 1/0/0.1011 multipoint
```

```
Switch(config-subif)# ip address 10.1.1.1 255.255.255.0
Switch(config-subif)# map-group net1011
Switch(config-subif)# atm pvc 2 1011 interface atm 3/0/0 0 1011 encap aal5snap
Switch(config-subif)# exit
Switch(config)# map-list net1011
Switch(config-map-list)# ip 10.1.1.2 atm-vc 1011
Switch(config-map-list)# end
Switch#
```

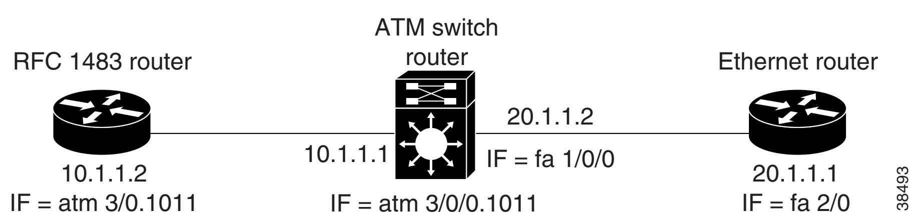
Multiprotocol Encapsulation over ATM Configuration Example

The following example shows how to configure for multiprotocol encapsulation over ATM with two routers and a ATM switch router.

The ATM switch router has an ATM router module in slot 0, a Fast Ethernet interface module in slot 1, and an ATM interface module in slot 3. One router has an ATM interface processor in slot 3. The other router has a Fast Ethernet interface module in slot 2.

Figure 25-7 shows an example of an RFC 1483 network.

Figure 25-7 Example Network for RFC 1483



Router with ATM Interface

```
RouterA# configure terminal
RouterA(config)# interface atm 3/0.1011 multipoint
RouterA(config-subif)# ip address 10.1.1.2 255.255.255.0
RouterA(config-subif)# atm pvc 1011 0 1011 aal5snap
RouterA(config-subif)# map group net1011
RouterA(config-subif)# ipx network 1011
RouterA(config-subif)# exit
RouterA(config)# map-list net1011
RouterA(config-map-list)# ip 10.1.1.1 atm-vc 1011
RouterA(config-map-list)# ipx 1011.1111.1111.1111 atm-vc 1011
RouterA(config-map-list)# exit
RouterA(config)#
```

ATM Switch Router

```
Switch# configure terminal
Switch(config)# interface atm 0/0/0.1011 multipoint
Switch(config-subif)# ip address 10.1.1.1 255.255.255.0
Switch(config-subif)# ipx network 1011
Switch(config-subif)# map-group net1011
Switch(config-subif)# atm pvc 2 1011 interface atm 3/0/0 0 1011
Switch(config-subif)# map-list net1011
Switch(config-map-list)# ip 10.1.1.2 atm-vc 1011
Switch(config-map-list)# ipx 1011.2222.2222.2222 atm-vc 1011
Switch(config-map-list)# exit
Switch(config)# interface fastethernet 1/0/0
```

```
Switch(config-if)# ip address 20.1.1.2 255.255.255.0
Switch(config-if)# ipx network 2011
Switch(config-if)# end
Switch#
```

Note The VCI in the **atm pvc** command must match the **atm-vc** VCI in the map list.

Ethernet Router

```
RouterB# configure terminal
RouterB(config)# ipx routing
RouterB(config)# interface fastethernet 2/0
RouterB(config-if)# ip address 20.1.1.1 255.255.255.0
RouterB(config-if)# ipx network 2011
RouterB(config-if)# end
RouterB#
```

Configuring Classical IP over ATM in a PVC Environment

This section describes how to configure classical IP over ATM, as described in RFC 1577, in a PVC environment on the ATM router module. The ATM Inverse ARP (InARP) mechanism is applicable to networks that use permanent virtual connections (PVCs), where connections are established but the network addresses of the remote ends are not known. For more information on configuring ATM ARP and ATM InARP, see Chapter 13, "Configuring IP over ATM,"

For a description of classical IP over ATM and RFC 1577, refer to the *Guide to ATM Technology*.

In a PVC environment, configure the ATM InARP mechanism on the ATM router module by performing the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies the ATM router module interface to configure.
Step 2	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 3	Switch(config-if)# **atm pvc 2** *vci* **interface atm** *card/subcard/port vpi vci* **encap** {**aal5mux**[1] | **aal5snap**} [**inarp** *minutes*]	Creates a PVC and enables ATM InARP. **Note** The VPI number on the ATM router module interface must be 2.

1. Only the Catalyst 8540 MSR enhanced ATM router module supports AAL5 MUX encapsulation.

Repeat these tasks for each PVC you want to create.

The **inarp** *minutes* interval specifies how often inverse ARP datagrams are sent on this virtual circuit. The default value is 15 minutes.

Example

The following example shows how to configure an IP-over-ATM interface on interface ATM 3/0/0, using a PVC with AAL5SNAP encapsulation, InARP set to ten minutes, VPI = 2, and VCI = 100:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# ip address 11.11.11.11 255.255.255.0
Switch(config-if)# atm pvc 2 100 interface atm 0/0/0 50 100 encap aal5snap inarp 10
```

Configuring Classical IP over ATM in an SVC Environment

This section describes how to configure classical IP over ATM in an SVC environment on your ATM router module. It requires configuring only the device's own ATM address and that of a single ATM Address Resolution Protocol (ARP) server into each client device.

For a detailed description of the role and operation of the ATM ARP server, refer to the *Guide to ATM Technology*.

The ATM switch router can be configured as an ATM ARP client, thereby being able to work with any ATM ARP server conforming to RFC 1577. Alternatively, one of the ATM switch routers in a logical IP subnet (LIS) can be configured to act as the ATM ARP server itself. In that case, it automatically acts as a client as well. The following sections describe configuring the ATM switch router in an SVC environment as either an ATM ARP client or an ATM ARP server.

Configuring as an ATM ARP Client

In an SVC environment, configure the ATM ARP mechanism on the interface by performing the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port* Switch(config-if)#	Selects the ATM router module interface.
Step 2	Switch(config-if)# **atm nsap-address** *nsap-address* or Switch(config-if)# **atm esi-address** *esi***.***selector*	Specifies the network service access point (NSAP) ATM address of the interface. or Specifies the end-system-identifier (ESI) address of the interface.
Step 3	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 4	Switch(config-if)# **atm arp-server nsap** *nsap-address*	Specifies the ATM address of the ATM ARP server.
Step 5	Switch(config-if)# **exit** Switch(config)#	Exits interface configuration mode.
Step 6	Switch(config)# **atm route** *addr-prefix*[1] **atm** *card***/***subcard***/***port* **internal**	Configures a static route through the ATM router module interface. See the note that follows this table.

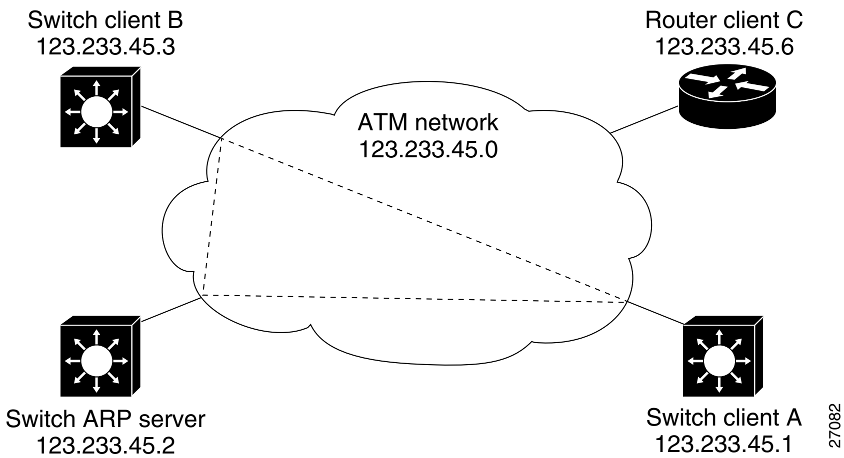
1. The address prefix is the first 19 bytes of the NSAP address.

Note The end system identifier (ESI) address form is preferred, in that it automatically handles the advertising of the address. Use the network service access point (NSAP) form of the command when you need to define a full 20-byte unique address with a prefix unrelated to the network prefix on that interface. You only need to specify a static route when configuring an ARP client using an NSAP address.

NSAP Address Example

Figure 25-8 shows three ATM switch routers and a router connected using classical IP over ATM.

Figure 25-8 Classical IP over ATM Connection Setup



The following example shows how to configure the ATM router module interface ATM 1/0/0 of Client A in Figure 25-8, using the NSAP address:

```
Client A(config)# interface atm 1/0/0
Client A(config-if)# atm nsap-address 47.0091.8100.0000.1111.1111.1111.1111.1111.1111.00
Client A(config-if)# ip address 123.233.45.1 255.255.255.0
Client A(config-if)# atm arp-server nsap 47.0091.8100.0000.1111.1111.1111.2222.2222.2222.00
Client A(config-if)# exit
Client A(config)# atm route 47.0091.8100.0000.1111.1111.1111.1111.1111.1111 atm 1/0/0 internal
```

ESI Example

The following example shows how to configure the ATM router module interface ATM 1/0/0 of Client A in Figure 25-8, using the ESI:

```
Client A(config)# interface atm 1/0/0
Client A(config-if)# atm esi-address 0041.0b0a.1081.40
Client A(config-if)# ip address 123.233.45.1 255.255.255.0
Client A(config-if)# atm arp-server nsap 47.0091.8100.0000.1111.1111.1111.2222.2222.2222.00
Client A(config-if)# exit
```

Configuring as an ATM ARP Server

Cisco's implementation of the ATM ARP server supports a single, nonredundant server per LIS, and one ATM ARP server per subinterface. Thus, a single ATM switch router can support multiple ARP servers by using multiple interfaces.

To configure the ATM ARP server, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***subinterface#*] Switch(config-if)#	Selects the Catalyst 8540 MSR enhanced ATM router module interface.
Step 2	Switch(config-if)# **atm nsap-address** *nsap-address* or Switch(config-if)# **atm esi-address** *esi***.***selector*	Specifies the NSAP ATM address of the interface. or Specifies the end-system-identifier address of the interface.
Step 3	Switch(config-if)# **ip address** *ip-address mask*	Specifies the IP address of the interface.
Step 4	Switch(config-if)# **atm arp-server time-out** *minutes*[1]	Configures the ATM ARP server optional idle timer.
Step 5	Switch(config-if)# **atm route** *addr-prefix*[2] **atm** *card***/***subcard***/***port* **internal**	Configures a static route through the optional ATM router module interface.

1. This form of the **atm arp-server** command indicates that this interface performs the ATM ARP server functions. When you configure the ATM ARP client (described earlier), the **atm arp-server** command is used—with a different keyword and argument—to identify a different ATM ARP server to the client.
2. Address prefix is the first 19 bytes of the NSAP address.

Note The ESI address form is preferred in that it automatically handles the advertising of the address. Use the NSAP form of the command when you need to define a full 20-byte unique address with a prefix unrelated to the network prefix on that interface. You only need to specify a static route when configuring an ARP server using an NSAP address.

The idle timer interval is the number of minutes a destination entry listed in the ATM ARP server's ARP table can be idle before the server takes any action to timeout the entry.

Example

The following example configures the route processor interface ATM 0 as an ARP server (shown in Figure 25-8):

```
ARP_Server(config)# interface atm 1/0/0
ARP_Server(config-if)# atm esi-address 0041.0b0a.1081.00
ARP_Server(config-if)# atm arp-server self
ARP_Server(config-if)# ip address 123.233.45.2 255.255.255.0
```

Displaying the IP-over-ATM Interface Configuration

To show the IP-over-ATM interface configuration, use the following EXEC commands:

Command	Purpose
show atm arp-server	Shows the ATM interface ARP configuration.
show atm map	Shows the ATM map list configuration.

Examples

In the following example, the **show atm arp-server** command displays the configuration of the interface ATM 1/0/0:

```
Switch# show atm arp-server

Note that a '*' next to an IP address indicates an active call

      IP Address        TTL     ATM Address
ATM1/0/0:
    * 10.0.0.5          19:21   4700918100567000000000112200410b0a108140
```

The following example displays the map-list configuration of the static map and IP-over-ATM interfaces:

```
Switch# show atm map
Map list ATM1/0/0_ATM_ARP : DYNAMIC
arp maps to NSAP 36.0091810000000003D5607900.0003D5607900.00
        , connection up, VPI=0 VCI=73, ATM2/0/0
ip 5.1.1.98 maps to s 36.0091810000000003D5607900.0003D5607900.00
        , broadcast, connection up, VPI=0 VCI=77, ATM2/0/0

Map list ip : PERMANENT
ip 5.1.1.99 maps to VPI=0 VCI=200
```

Configuring Bridging

All PVCs configured on ATM router module interfaces are used for bridging.

To configure bridging on an ATM router module interface, use the following commands, beginning in global configuration mode:

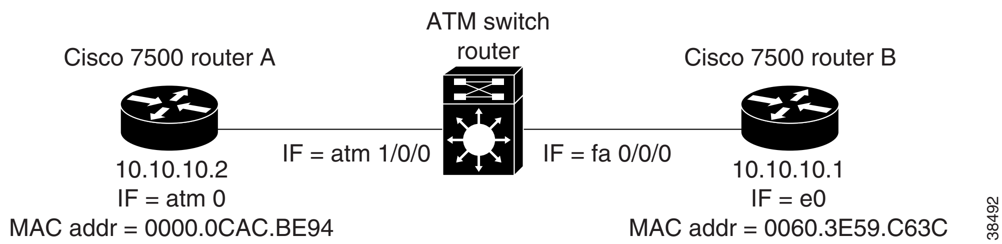
	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port* Switch(config-if)#	Specifies the interface on the ATM router module to configure.
Step 2	Switch(config-if)# **atm pvc 2** *vci* **interface atm** *card/subcard/port vpi*	Configures a PVC. **Note** The VPI number on the ATM router module interface must be 2.
Step 3	Switch(config-if)# **bridge-group** *number*	Assigns the interface to a bridge group.
Step 4	Switch(config-if)# **end** Switch(config)#	Returns to global configuration mode.
Step 5	Switch(config)# **interface fastethernet** *card/subcard/port* Switch(config-if)#	Specifies the Fast Ethernet interface to configure.
Step 6	Switch(config-if)# **no cdp enable**	Disables Cisco Discovery Protocol on the interface.
Step 7	Switch(config-if)# **bridge-group** *number*	Assigns the interface to a bridge group.
Step 8	Switch(config-if)# **end** Switch(config)#	Returns to global configuration mode.
Step 9	Switch(config)# **bridge** *number* **protocol ieee**	Specifies the IEEE 802.1D Spanning-Tree Protocol for the bridge group.

Example

The following example shows how to configure bridging on a Catalyst 8540 MSR with a Fast Ethernet interface module in slot 0, an ATM interface module in slot 1, and an ATM router module in slot 3.

Figure 25-9 shows an example bridging network.

Figure 25-9 Example Network for Bridging




```
Switch(config)# interface atm 3/0/0
Switch(config-if)# atm pvc 2 200 interface atm 1/0/0 0 200
Switch(config-if)# bridge-group 5
Switch(config-if)# end
```

```
Switch(config)# interface fastethernet 0/0/0
Switch(config-if)# no cdp enable
Switch(config-if)# bridge-group 5
Switch(config-if)# end
Switch(config)# bridge 5 protocol ieee
```

Configuring Packet Flooding on a PVC

Typically, a specific static map list configuration is not required for bridging to occur. In case of packet flooding, the bridging mechanism individually sends the packet to be flooded on all PVCs configured on the interface. To restrict the broadcast of the packets to only a subset of the configured PVCs you must define a separate static map list. Use the **broadcast** keyword in the **static-map** command to restrict packet broadcasting.

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies the interface to configure on the ATM router module.
Step 2	Switch(config-if)# **no ip address**	Disables IP processing.
Step 3	Switch(config-if)# **no ip directed-broadcast**	Disables the translation of directed broadcasts to physical broadcasts.
Step 4	Switch(config-if)# **map-group** *number*	Enters the map group name associated with this PVC.
Step 5	Switch(config-if)# **atm pvc 2** *vci-A* **interface atm** *card*/*subcard*/*port vpi-B*	Configures a PVC. **Note** The VPI number on the ATM router module interface must be 2.
Step 6	Switch(config-if)# **bridge-group** *number*	Assigns the interface to a bridge group.
Step 7	Switch(config-if)# **end** Switch(config)#	Returns to global configuration mode.
Step 8	Switch(config)# **map-list** *name* Switch(config-map-list)#	Creates a map list by naming it, and enters map-list configuration mode.
Step 9	Switch(config-map-list)# **bridge atm-vc** *number* **broadcast**	Enables packet flooding on a PVC.

Example

In the following example only PVC 2, 200 is used for packet flooding:

```
Switch(config)# interface atm 3/0/0
Switch(config-if)# no ip address
Switch(config-if)# no ip directed-broadcast
Switch(config-if)# map-group bg_1
Switch(config-if)# atm pvc 2 200 interface atm 1/0/1 0 200
Switch(config-if)# atm pvc 2 201 interface atm 1/0/1 0 300
Switch(config-if)# bridge-group 5
Switch(config-if)# end
Switch(config)# map-list bg_1
Switch(config-map-list)# bridge atm-vc 200 broadcast
```

Note For more information about bridging, refer to the *Layer 3 Software Configuration Guide*.

Displaying the Bridging Configuration

To display the bridging configuration on the ATM router module interface, use the following privileged EXEC command:

Command	Purpose
show bridge verbose	Displays the entries in the bridge forwarding database.

Example

```
Switch# show bridge verbose

Total of 300 station blocks, 297 free
Codes: P - permanent, S - self
BG Hash      Address      Action  Interface         VC    Age   RX count   TX count
 5 28/0   0000.0ce4.341c forward  Fa0/0/0              -
 5 2A/0   0000.0cac.be94 forward  ATM3/0/0             200
 5 FA/0   0060.3e59.c63c forward  Fa0/0/0              -
```

Configuring IP Multicast

To configure IP multicast over an RFC 1483 permanent virtual connection (PVC) on an ATM router module, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **ip multicast-routing**	Enables IP multicast routing.
Step 2	Switch(config)# **interface atm** *card***/***subcard***/***port***.***subinterface#* **multipoint** Switch(config-subif)#	Creates the ATM router module point-to-multipoint subinterface, and enters subinterface mode. **Note** The ATM router module only supports point-to-multipoint subinterfaces.
Step 3	Switch(config-subif)# **map-group** *name*	Enters the map group name associated with this PVC.
Step 4	Switch(config-subif)# **atm pvc 2** *vci-a* [**upc** *upc*] [**pd** *pd*] **interface atm** *card***/***subcard***/***port*[**.***vpt#*] *vpi-b vci-b* [**upc** *upc*] **encap aal5snap**	Configures the PVC. **Note** The VPI number on the ATM router module interface must be 2.
Step 5	Switch(config-subif)# **ip pim dense-mode**	Enables Protocol Independent Multicast dense mode on the subinterface.
Step 6	Switch(config-subif)# **exit** Switch(config)#	Returns to global configuration mode.
Step 7	Switch(config)# **map-list** *name* Switch(config-map-list)#	Creates a map list by naming it, and enters map-list configuration mode.
Step 8	Switch(config-map-list)# **ip** *ip-address* {**atm-nsap** *address* **|** **atm-vc** *vci*} **broadcast**	Associates a protocol and address with a specific virtual circuit.
Step 9	Switch(config-map-list)# **end** Switch#	Returns to privileged EXEC mode.

Example

```
Switch(config)# ip multicast-routing
Switch(config)# interface atm 1/0/0.1011 multipoint
Switch(config-subif)# ip address 10.1.1.1 255.255.255.0
Switch(config-subif)# map-group net1011
Switch(config-subif)# atm pvc 2 1011 interface atm 3/0/0 0 1011 encap aal5snap
Switch(config-subif)# ip pim dense-mode
Switch(config-subif)# exit
Switch(config)# map-list net1011
Switch(config-map-list)# ip 10.1.1.2 atm-vc 1011 broadcast
```

Note For more information on IP multicast, refer to the *Layer 3 Software Configuration Guide*.

About Rate Limiting

Rate limiting is available on the Catalyst 8540 MSR, Catalyst 8510 MSR, Catalyst 8540 CSR, and Catalyst 8510 CSR. This feature is similar to the IOS committed access rate (CAR) feature. You can deploy rate limiting on your switch router to ensure that a packet, or data source, adheres to a stipulated contract, and to determine the QoS for a packet.

Rate limiting can be applied to individual interfaces. When an interface is configured with this feature, the traffic rate will be monitored by the Ethernet processor interface microcode to verify conformity. Non-conforming traffic is dropped, conforming traffic passes through without any changes.

Features Supported

The following features are supported for rate limiting on the Catalyst 8500 switch router:

- This feature is supported on the following interface modules:
  - Eight-Port 10/100BASE-T Fast Ethernet Interface Modules
  - 16-Port 10/100BASE-T Fast Ethernet Interface Modules
  - Eight-Port 100BASE-FX Fast Ethernet Interface Modules
  - 16-port 100BASE-FX Fast Ethernet Interface Modules
- This feature can be applied on a per-physical-port basis.
- This feature is available for input traffic and output traffic.

Restrictions

Restrictions for rate limiting on the Catalyst 8500 switch router include the following:

- This feature is not supported on the LightStream 1010.
- IPX and rate limiting cannot be configured at the same time. If rate limiting is configured on an interface, IPX will be automatically disabled on that interface. In addition, IPX will be automatically disabled on any of the three other interfaces which are controlled by the same hardware micro-controller as the configured interface. For example, if rate limiting is configured on Fast Ethernet slot 0, IPX will not work on slots 0, 1, 2, and 3.
- The QoS mapping ratio might be disrupted by the rate limiting configuration.
- Due to additional processing, when rate limiting is enabled, switching might not be at wire speed.

Note Broadcast packets, dropped ACL packets, packets dropped due to expiration of the designed Time To Live, and bad CRC packets are included in the rate limit calculation. This might cause a problem if the policed port is not part of a point-to-point connection and is connected via a hub rather than a layer 2 switch.

Configuring Rate Limiting

Enter the following command in interface configuration mode to configure rate limiting on your switch router:

Command	Purpose
rate-limit {**input** | **output**} *rate burst*	Configures rate limiting on an interface.

For more detailed configuration information, refer to the “Policing and Shaping Overview” section of the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Example

The following is an example of how to configure rate limiting on your switch router:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z
Router(config)# interface f0/0/0
Router(config-if)# rate-limit input 1000000 20000
Router(config-if)# rate-limit output 100000 30000
Router(config-if)# exit
```

Configuring VC Bundling

This section describes the ATM virtual circuit (VC) bundle management on the enhanced ATM Router Module. The ATM VC bundle management feature allows you to configure multiple VCs that have different QoS characteristics between any pair of ATM-connected routers or Catalyst 8500 MSRs.

Note The VC-Bundle feature is only applicable for enhanced ATM Router Modules installed in the Catalyst 8540 MSR chassis.

Overview

The VC bundle management feature allows you to define an ATM VC bundle and add VCs to it. Each VC bundle has its own ATM traffic class and ATM traffic parameters, and you can apply attributes and characteristics collectively at the VC bundle level.

Using VC bundles, you can create differentiated service by flexibly distributing IP precedence levels over the different VC bundle members. You can map a single precedence level or a range of levels to each discrete VC in the bundle, thereby enabling individual VCs in the bundle to carry packets marked with different precedence levels.

Benefits

The following benefits apply for VC bundle management:

- Provides flexible configuration of different service categories such as UBR or VBR with different parameters for traffic with different precedence levels.
- Provides flexible VC management within a VC bundle in the event of a PVC failure, also referred to as VC bumping. It allows traffic assigned to a failed VC to be redirected to an alternate VC within the VC bundle.

Restrictions

The following restrictions apply for VC bundle management:

- On a point-to-point subinterface, you can configure either one regular PVC or one VC bundle, which can contain up to eight VC bundle members, but not both.
- VC bundle management is supported for PVCs only, not switched virtual circuits (SVCs).
- Only aal5snap and aal5mux encapsulation types are supported for IP VC bundles.
- Only aal5snap encapsulation is supported for IPX VC bundles.
- A maximum of 200 VC bundles can be configured on an interface (including subinterfaces).

To configure the VC bundle, use the following commands, beginning in global configuration mode:

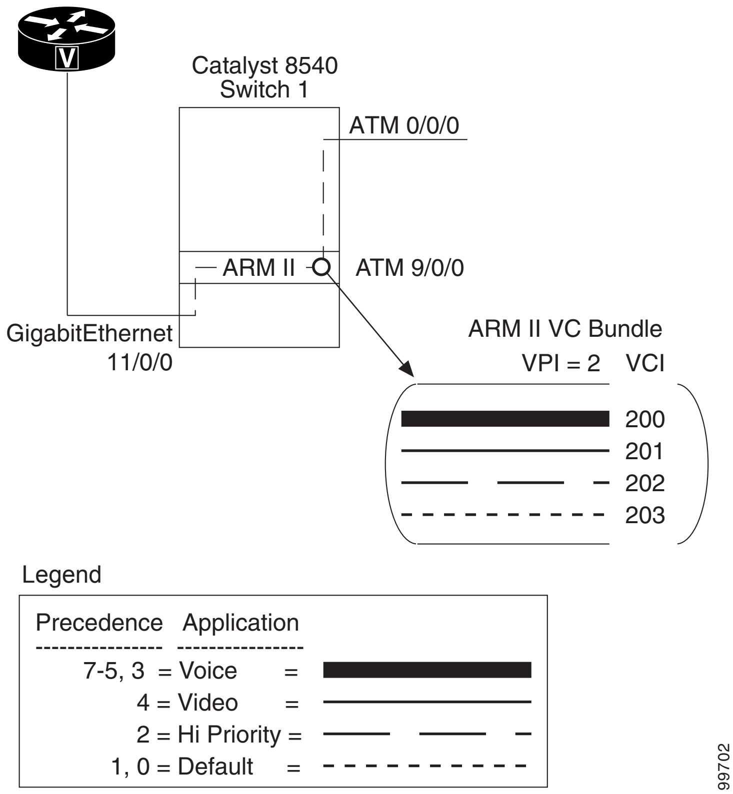
	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port***.***subinterface#* **multipoint** Switch(config-subif)#	Creates the ATM Router Module point-to-multipoint subinterface and enters subinterface mode.
Step 2	Switch(config-subif)# **ip address** *ip-address mask*	Provides a protocol address and subnet mask for the client on this subinterface.
Step 3	Switch(config-subif)# **bundle** *name* Switch(config-if-atm-bundle)#	Creates the VC bundle changes to VC bundle configuration mode.
Step 4	Switch(config-if-atm-bundle)# **protocol** {*ip-address* | **ip** *ip-address* | **ipx** *ipx-address* | **inarp**} [[**no**] **broadcast**]	Configures the VC bundle protocol.
Step 5	Switch(config-if-atm-bundle)# **oam-bundle manage** *frequency-seconds*	Enables end-to-end F5 OAM loopback cell generation and OAM management for all VCs in the VC bundle.
Step 6	Switch(config-if-atm-bundle)# **pvc-bundle** *vpi vci* **interface atm** *card/subcard/port vpi vci* [**upc** {**tag** | **drop** | **pass**}] [**pd** {**on** | **off** | **use-cttr**}] [**rx-cttr** *rx-row*] [**tx-cttr** *tx-row*] [**wrr-weight** *value*] Switch(config-if-atm-member)#	Configures the VC bundle member and changes to VC bundle member configuration mode.
Step 7	Switch(config-if-atm-member)# **precedence** {**other** | *range*}	Configures the precedence level associated with the VC bundle member.
Step 8	Switch(config-if-atm-member)# **bump** {**implicit** | **explicit** *precedence-level* | **traffic**}	Configures the bumping rules (switching if a VC fails) for a specific VC bundle member.
Step 9	Switch(config-if-atm-member)# **protect** {**group** | **vc**}	Configures the VC to belong to a protected group or to be individually protected.
Step 10	Switch(config-if-atm-member)# **exit** Switch(config-if-atm-bundle)#	Exits back to VC bundle configuration mode to configure another PVC in the bundle.

VC Bundle Examples

The VC bundle configuration, shown in Figure 25-10, has eight PVCs bundled into one multipoint subinterface at ATM 9/0/0 on the enhanced ATM router module. The PVCs have the IP precedence set to the following applications:

- IP precedence 7, 6, 5, and 3 used for the voice application
- IP precedence 4 used for the video application
- IP precedence 2 used for the high priority applications
- IP precedence 1 and 0 are used for all remaining (default) applications

Figure 25-10 VC Bundle Example Configuration



The following configuration example also provides for flexible VC management within the VC bundle in the event of a PVC failure, also referred to as VC bumping. Bumping allows traffic assigned to a failed VC to be redirected to an alternate VC within the VC bundle. In this example, if PVC 2, 200 fails it is bumped to the VC with IP precedence 3.

The following example configures eight PVCs as members of a VC bundle named *cisco*.

```
Switch(config)# interface atm 9/0/0.1 multipoint
Switch(config-subif)# ip address 1.1.1.9 255.0.0.0
Switch(config-subif)# bundle cisco
Switch(config-if-atm-bundle)# protocol ip inarp
Switch(config-if-atm-bundle)# pvc 2 200 interface atm 0/0/0 2 100
Switch(config-if-atm-member)# precedence 7
Switch(config-if-atm-member)# bump explicit 3
Switch(config-if-atm-member)# pvc 2 201 interface atm 0/0/0 2 101
Switch(config-if-atm-member)# precedence 6
Switch(config-if-atm-member)# pvc 2 202 interface atm 0/0/0 2 102
Switch(config-if-atm-member)# precedence 5
Switch(config-if-atm-member)# pvc 2 203 interface atm 0/0/0 2 103
Switch(config-if-atm-member)# precedence 4
Switch(config-if-atm-member)# pvc 2 204 interface atm 0/0/0 2 104
Switch(config-if-atm-member)# precedence 3
Switch(config-if-atm-member)# pvc 2 205 interface atm 0/0/0 2 105
Switch(config-if-atm-member)# precedence 2
Switch(config-if-atm-member)# pvc 2 206 interface atm 0/0/0 2 106
Switch(config-if-atm-member)# precedence 1
Switch(config-if-atm-member)# pvc 2 207 interface atm 0/0/0 2 107
Switch(config-if-atm-member)# precedence 0
Switch(config-if-atm-member)#
```

Continue with the next section to confirm the VC bundle configuration and status.

Displaying the VC Bundle Configuration

To display the VC bundle configuration and status, use the following EXEC commands:

Command	Purpose
show atm bundle	Shows the ATM VC bundle configuration.
show atm bundle *bundle-name* **stat**	Shows the ATM VC bundle statistics.
show running-config	Shows the ATM VC bundle configuration.

Examples

In the following example, the **show atm bundle** command displays the configuration of the VC bundle:

```
Switch# show atm bundle cisco

cisco on ATM9/0/0.1: UP

                                        Config    Current    Bumping  PG/
 VPI  VCI  X-Interface      X-VPI X-VCI Preced.   Preced.    Preced./ PV  Sts
                                                             Accept

 2    200  ATM0/0/0         0     200   7         7          3 / Yes      UP
 2    201  ATM0/0/0         0     201   6         6          5 / Yes      UP
 2    202  ATM0/0/0         0     202   5         5          4 / Yes      UP
 2    203  ATM0/0/0         0     203   4         4          3 / Yes      UP
 2    204  ATM0/0/0         0     204   3         3          2 / Yes      UP
 2    205  ATM0/0/0         0     205   2         2          1 / Yes      UP
 2    206  ATM0/0/0         0     206   1         1          0 / Yes      UP
 2    207  ATM0/0/0         0     207   0         0            / Yes      UP
Switch#
```

In the following example, the **show atm bundle stat** command displays the statistics for the VC bundle:

```
Switch# show atm bundle cisco stat
cisco on ATM12/0/0.1: UP

VCI      Rx-cells     Tx-cells X-Interface X-VPI X-VCI     Rx-cells     Tx-cells
200             0            0 ATM0/0/0    0     200              0            0
201             1            1 ATM0/0/0    0     201              1            1
202             0            0 ATM0/0/0    0     202              0            0
203             0            0 ATM0/0/0    0     203              0            0
204             0            0 ATM0/0/0    0     204              0            0
205             0            0 ATM0/0/0    0     205              0            0
206             0            0 ATM0/0/0    0     206              0            0
207             0            0 ATM0/0/0    0     207              0            0
Switch#
```

In the following example, the **show running-config** command displays the configuration for the VC bundle:

```
Switch# show running-config interface atm11/0/0.1
Building configuration...

Current configuration : 686 bytes
!
interface ATM11/0/0.1 multipoint
 ip address 1.1.1.9 255.0.0.0
 bundle cisco
  protocol ip inarp
  pvc-bundle 2 200 pd on  interface  ATM0/0/0 0 200
   precedence 7
   bump explicit 3
  pvc-bundle 2 201 pd on  interface  ATM0/0/0 0 201
   precedence 6
  pvc-bundle 2 202 pd on  interface  ATM0/0/0 0 202
   precedence 5
  pvc-bundle 2 203 pd on  interface  ATM0/0/0 0 203
   precedence 4
  pvc-bundle 2 204 pd on  interface  ATM0/0/0 0 204
   precedence 3
  pvc-bundle 2 205 pd on  interface  ATM0/0/0 0 205
   precedence 2
  pvc-bundle 2 206 pd on  interface  ATM0/0/0 0 206
   precedence 1
  pvc-bundle 2 207 pd on  interface  ATM0/0/0 0 207
   precedence 0
 !
end

Switch#
```

Configuring VC Bundling with IP and ATM QoS

This section describes the ATM virtual circuit (VC) bundle management on the enhanced ATM Router Module with IP/ATM QoS configured. The ATM VC bundle management feature allows you to configure multiple VCs that have different QoS characteristics between any pair of ATM-connected routers or Catalyst 8500 MSRs.

Note The VC-bundle feature is only applicable for enhanced ATM Router Modules installed in the Catalyst 8540 MSR chassis.

The VC bundle management feature allows you to define an ATM VC bundle and add VCs to it as needed. Each VC bundle has its own ATM traffic class and ATM traffic parameters, and you can apply attributes and characteristics collectively at the VC bundle level.

Using VC bundles, you can create differentiated service by distributing IP precedence levels among the different VC bundle members. You can then map a single precedence level or a range of levels to each discrete VC in the bundle, thereby enabling individual VCs in the bundle to carry packets marked with different precedence levels.

VC bundling with IP and ATM QoS has the same benefits and restrictions as VC bundling described in the section, "Configuring VC Bundling".

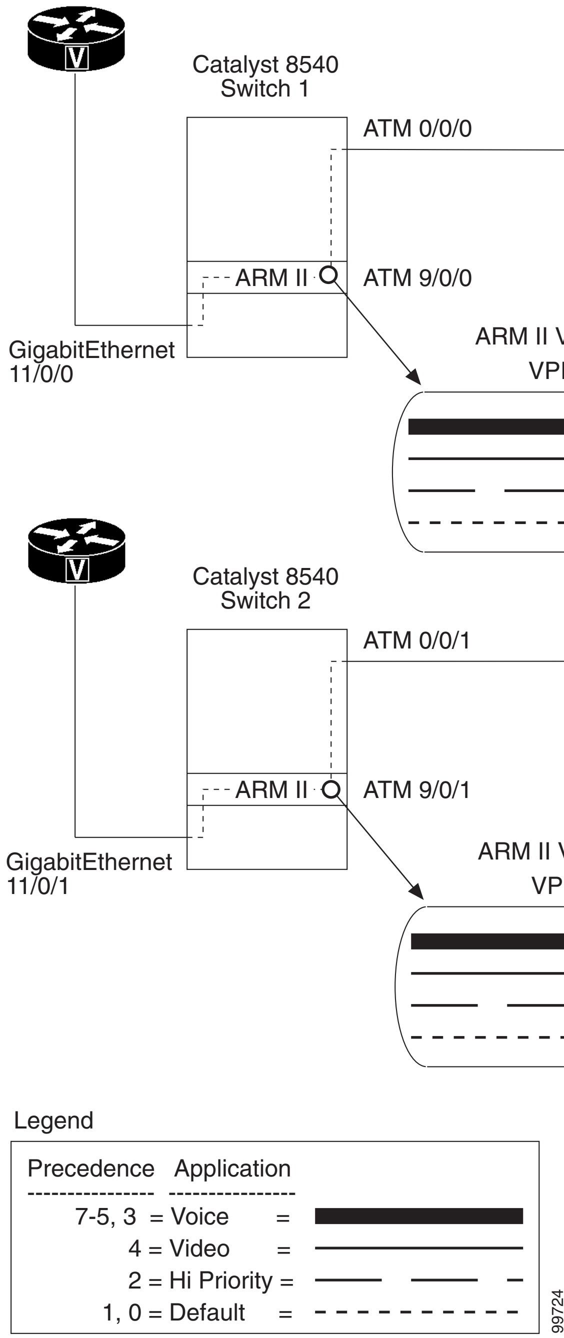
Configuring IP to ATM QoS and VC bundling on the enhanced ATM router module requires the steps in the following sections:

- "Configure Input IP Processing"
- "Configure Per-Hop Behavior and Output Processing"
- "Mapping the IP to ATM Configuration"

The VC bundle configuration with IP to ATM QoS, shown in Figure 25-11, has eight PVCs bundled into the multipoint subinterfaces on each of the enhanced ATM router modules. The PVCs have the IP precedence set to the following applications:

- IP precedence 7, 6, 5, and 3 for the voice application
- IP precedence 4 for the video application
- IP precedence 2 for the high priority applications
- IP precedence 1 and 0 are for all remaining (default) applications

Figure 25-11 VC Bundle Example Configuration with IP to ATM QoS



Configure Input IP Processing

This section describes configuring the input processing on Gigabit Ethernet interfaces in an IP to ATM QoS VC bundle on an enhanced ATM router module.

Configure the BA or MF Classifiers

Classifiers read an IP packet header and can classify packets based on the IP source or destination address, TCP or UDP source or destination port, and/or the Layer 4 protocol. These are called Multi-Field (MF) classifiers. Classifiers can classify packets based on IP Precedence Level or IP DiffServe Code Point (DSCP). These are called behavior aggregate (BA) classifiers.

Either MF or BA classifiers can be used for an input class. Only BA classifiers can be used for an output class. Classifiers are configured using the class-map commands. Class-map commands use access lists for MF classifiers to qualify packets for a particular class.

To configure the MF or BA classifiers, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **class-map** *name* [**match-all** | **match-any**] Switch(config-cmap)#	Specifies the match criteria in the class map and changes to QoS class map configuration mode.
Step 2	Switch(config-cmap)# **match** {**access-group** {*acl-index* | *acl-name*} | **any** | **class-map** | **destination-address mac** *mac-address* | **input-interface** {{*interface-type card/subcard/port*} | {**null** *number*} | {**vlan** *vlan-id*}}| **ip** {**dscp** | **precedence**} *value1 value2 ... value8* | **not** | **protocol** { **ip** | **ipc** | **vofr**} | **qos-group** *group-value* | **source-address mac** *mac-address*}	Specifies the classification criteria
Step 3	Switch(config)# **access-list** *number* **permit udp** *ip-address mask* **any eq** *port-number*	Configures the voice signaling access list.

Example

The following example classifies the voice packets based on IP precedence (BA classifier) and voice signaling packets based on source IP address and UDP port (MF classifier).

```
Switch1(config)# class-map match-all voice
Switch1(config-cmap)# match ip precedence 3 5 6 7
Switch1(config-cmap)# exit
Switch1(config)# class-map match-all ABC-signaling-host
Switch1(config-cmap)# match access-group 101
Switch1(config-cmap)# end
Switch1(config)# access-list 101 permit udp 7.0.0.0 0.0.0.255 any eq 2556
```

Displaying the BA or MF Classifier Configuration

To display the MF or BA classifier configuration on the ATM router module interface, use the following privileged EXEC commands:

Command	Purpose
show class-map [*class-name*]	Displays the class map information.
show access-lists [*aclnumber* | *aclname*]	Displays the access list.

Example

In the following example, the **show class-map** command displays the configuration of the class-maps:

```
Switch1# show class-map
 Class Map match-any class-default (id 0)
   Match any
 Class Map match-all ABC-signaling-host (id 3)
   Match access-group  101

 Class Map match-all voice (id 2)
   Match ip precedence 3 5 6 7

Switch1#
```

In the following example, the **show ip access-list** command displays the configuration of the voice signaling access list:

```
Switch1# show ip access-lists 101
Extended IP access list 101
    permit udp 7.0.0.0 0.0.0.255 any eq 2556
Switch1#
```

Configure and Apply the Input Policy Map

On the GigabitEtherrnet interfaces and enhanced ATM router module subinterfaces the signaling packets must be marked for IP precedence 3. This allows end-to-end QoS policies in mixed IP to ATM network.

To configure the signaling packets with an IP precedence to 3, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# p**olicy-map** *policy-map-name* Switch1(config-pmap)#	Specifies the policy map name with changes to the policy map configuration mode.
Step 2	Switch1(config-pmap)# **class** *class-map* [*name*] Switch1(config-pmap-c)#	Specifies a previously created class map to be included in the policy map or creates a class map with changes to the QoS class map configuration mode.
Step 3	Switch1(config-pmap-c)# **set ip precedence** *number*	Sets the IP precedence number.

Example

The following example maps the voice packets signaling packets to a policy map from the previously configured class may and sets the IP precedence value.

```
Switch1(config)# policy-map ABC-signaling-mark
Switch1(config-pmap)# class ABC-signaling-host
Switch1(config-pmap-c)# set ip precedence 3
Switch1(config-pmap-c)#
```

The QoS policies feature enables you to apply a service policy inside a policy map and is typically used to mark the input at the interface level. To apply the input service policy on the enhanced Gigabit Ethernet interface or enhanced ATM router module subinterface, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface** {**gigabitEthernet** *card*/*subcard*/*port* | **atm** *card*/*subcard*/*port*[.*subinterface#*]} Switch(config-if)#	Specifies the Gigabit Ethernet interface or ATM subinterface and enters interface configuration mode.
Step 2	Switch(config-if)# **service-policy** {**input** | **output**} *policy-map-name*	Attaches the policy map you specify to the interface.

Example

The following example applies a service policy to the Gigabit Ethernet interface:

```
Switch1(config)# interface gigabitEthernet 11/0/0
Switch1(config-if)# service-policy input mark
Service policy mark is already attached
Switch1(config-if)#
Switch1#
```

When the ABC signaling packets enter the switch from the ATM interface, the policy map is applied to the enhanced ATM router module subinterfaces. If ABC signaling packets enter the switch from the Gigabit Ethernet interface, then the same policy map must be applied on the XPIF Gigabit Ethernet interface.

Note There is no IP QoS support on EPIF based interface modules, including the original ATM router module.

Displaying the Input Map Policy

To display the input map policy configuration on the ATM router module interface, use the following privileged EXEC command:

Command	Purpose
show epc ipqos database interface {*interface-type card/subcard/port*} **input**	Displays the input map policy configuration information.

Configure Per-Hop Behavior and Output Processing

This section describes configuring the output queues on the ATM QoS VC bundle on an enhanced ATM router module.

Configuring Output Queues Based on BA Classifiers

This section describes configuring the output queues based on the behavior aggregate (BA) classifiers. A maximum of four output queues can be configured for each interface (including class-default).

Note Class-default matches traffic not matched by the three classifiers.

To configure the BA classifiers, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **class-map** *name* [**match-all** | **match-any**] Switch(config-cmap)#	Specifies the match criteria in the class map and changes to QoS class map configuration mode.
Step 2	Switch(config-cmap)# **match** {**access-group** {*acl-index* | *acl-name*} | **any** | **class-map** | **destination-address mac** *mac-address* | **input-interface** {{*interface-type card/subcard/port*} | {**null** *number*} | {**vlan** *vlan-id*}}| **ip** {**dscp** | **precedence**} *value1 value2 ... value8* | **not** | **protocol** { **ip** | **ipc** | **vofr**} | **qos-group** *group-value* | **source-address mac** *mac-address*}	Specifies the classification criteria.

Example

The following example classifies the three BA classifiers. They correspond to the three output queue.

```
Switch1(config)# class-map match-all hipri
Switch1(config-cmap)# match ip precedence 2
Switch1(config-cmap)# exit
Switch1(config)# class-map match-all mark-video
Switch1(config-cmap)# match access-group 151
Switch1(config-cmap)# exit
Switch1(config)# class-map match-all mark-voice
Switch1(config-cmap)# match access-group 150
Switch1(config-cmap)# end
Switch1#
```

Displaying the BA Classifier Configuration

To display the BA classifier configuration on the ATM router module interface, use the following privileged EXEC command:

Command	Purpose
show class-map [*class-name*]	Displays the class map information.

Example

In the following example, the **show class-map** command displays the configuration of the class-maps:

```
Switch1# show class-map
Class Map match-any class-default (id 0)
   Match any
 Class Map match-all ABC-signaling-host (id 3)
   Match access-group  101

 Class Map match-all mark-video (id 5)
   Match access-group  151

 Class Map match-all mark-voice (id 6)
   Match access-group  150

 Class Map match-all hipri (id 4)
   Match ip precedence 2

 Class Map match-all voice (id 2)
   Match ip precedence 3 5 6 7

Switch1#
```

Configuring Output Policy Map

Consider the following key item when configuring IP to ATM QoS on an enhanced ATM router module:

- There is a maximum of four scheduler classes that can be used.
- The four scheduler classes are configured on the output policy map with the “bandwidth” command.
- The maximum cumulative bandwidth that can be configured in the four policy maps is 1Gbps, but only 500 Mbps can be allocated.

Note See the “Calculating the Scheduler Class Weights” section for information on calculating weights and bandwidth for IP QoS queues.

In the example network shown in Figure 25-11, the following four classes are used to decide what bandwidth associated with each of the four classes. All traffic will eventually be mapped to these four classes. In the example network, the 500 Mbps is allocated as follows:

- Voice—200 Mbps
- Video—175 Mbps
- Hi Priority IP—100 Mbps,
- Default IP— 25 Mbps

To configure the bandwidth associated with each of the four classes, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# p**olicy-map** *policy-map-name* Switch1(config-pmap)#	Specifies the policy map name and changes to policy map configuration mode.
Step 2	Switch(config-pmap) # **class** *class-name*	Specifies the name of a predefined class, which was defined with the c**lass-map** command.
Step 3	Switch(config-pmap-c) # **bandwidth** *kbps*	Specifies a minimum bandwidth (in Kbits/sec) guaranteed to a traffic class. This must be specified for each class in the output policy, including class-default.
Step 4	Switch(config-pmap-c) # **random-detect** [**buffer-group** *buffer-group-number* | **max-probability** *max-probability* | **freeze-time** *millisecond*]	Enables and configures the XPIF based Random Early Detect (xRED) drop policy.
Step 5	Switch(config-pmap-c) # **class class-default**	Specifies the default class.
Step 6	Switch(config-pmap-c) # **exit** Switch(config-pmap) #	Exits back to policy map configuration mode.

Example

The following example configures the bandwidth associated with each of the four classes on a policy map named *arm2-switch1*:

```
Switch1(config)# policy-map arm2-switch1
Switch1(config-pmap)# class voice
Switch1(config-pmap-c)# bandwidth 200000 random-detect buffer-group 3 max-probability 100
freeze-time 15
Switch1(config-pmap-c)# exit
Switch1(config-pmap)# class video
Switch1(config-pmap-c)# bandwidth 175000 random-detect buffer-group 2 max-probability 100
freeze-time 15
Switch1(config-pmap-c)# exit
Switch1(config-pmap)# class HiPri
Switch1(config-pmap-c)# bandwidth 100000 random-detect buffer-group 1 max-probability 100
freeze-time 15
Switch1(config-pmap-c)# exit
Switch1(config-pmap)# class class-default
Switch1(config-pmap-c)# bandwidth 25000 random-detect buffer-group 0 max-probability 100
freeze-time 15
Switch1(config-pmap-c)# end
Switch1#
```

Displaying the Policy Map Configuration

To display the policy map configuration, use the following privileged EXEC command:

Command	Purpose
show policy-map [*policy-map-name*]	Displays the policy map information.

Example

In the following example, the **show policy-map** command displays the configuration of the policy-map a*rm2-switch1*:

```
Switch1# show policy-map arm2-switch1
Policy Map arm2-switch1
   class  voice
   bandwidth   200000
   random-detect buffer-group 3 max-probability 100 freeze-time 15
  class  video
   bandwidth   175000
   random-detect buffer-group 2 max-probability 100 freeze-time 15
  class  HiPri
   bandwidth   100000
   random-detect buffer-group 1 max-probability 100 freeze-time 15
  class  class-default
   bandwidth   25000
   random-detect buffer-group 0 max-probability 100 freeze-time 15

Switch1#
```

Applying the Output Policy Map on the Enhanced ATM Router Module

This section describes applying the policy map to the output enhanced ATM router module.

To apply the output service policy on the enhanced ATM router module subinterface, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card***/***subcard***/***port*[**.***subinterface#*] Switch(config-if)#	Specifies the Gigabit Ethernet interface or ATM subinterface and enters interface configuration mode.
Step 2	Switch(config-if)# **service-policy** {**input** | **output**} *policy-map-name*	Attaches the policy map you specify to the interface.

Example

The following example applies a service policy to the Gigabit Ethernet interface:

```
Switch1(config)# interface atm 9/0/0
Switch1(config-if)# service-policy output arm2-switch1
Switch1(config-if)# end
Switch1#
```

Displaying the Output Policy Interface Configuration

To display the policy map configuration on the enhanced ATM router module interface, use the following privileged EXEC command:

Command	Purpose
show epc ipqos output interface *interface-type card/subcard/port*	Displays the policy map informaiton information.

Example

In the following example, the **show epc ipqos output interface** command displays the configuration of the policy-map a*rm2-switch1* on the enhanced ATM router module:

```
Switch1# show epc ipqos output interface atm 9/0/0
Policy Assigned       : TRUE     Initialized               : TRUE
Broute VCs Created    : TRUE     CoS Enabled               : TRUE
IPQOS HW interface Num: 8        Number of Assigned Classes: 4
MMC Port: 68        MSC ID: 4       Port num in MSC:0

Policy Name           : arm2-switch1
Queue Class Class      Sched Wei/Pri Buff  Copied   Default  EPD   EFCI  Drop
      ID    Name                          From Def. Traffic              Policy
0     3     class-defa WRR   16      0      FALSE    TRUE    TRUE  TRUE  XRED
1     2     hipri      WRR   25      1      FALSE    FALSE   TRUE  TRUE  XRED
2     1     video      WRR   44      2      FALSE    FALSE   TRUE  TRUE  XRED
3     0     voice      WRR   51      3      FALSE    FALSE   TRUE  TRUE  XRED
4     255              WRR   255     4      TRUE     FALSE   TRUE  FALSE TAIL (IPC)

Switch1#
```

Mapping the IP to ATM Configuration

In our example topology, shown in Figure 25-11, the ATM tunnel interface ATM 0/0/0.11 is connected to the Catalyst 8540 MSR at Switch 2. This requires the PVCs and bundled PVCs terminating on the enhanced ATM router module subinterfaces to transit the correct ATM tunnel port depending on the destination.

Creating the Traffic Rows for PVCs and VC-bundle Members

The link from Switch 1 to Switch 2 is 10 Mbps. Hence we need one CTTR row of type CBR for creating the hierarchical tunnel, and the others for CBR/VBR VCs transiting this tunnel.

For information about creating hierarchical tunnels see the, "Configuring a Hierarchical VP Tunnel for Multiple Service Categories" section.

The following commands configure the connection traffic table rows needed for the ATM connection between Switch 1 and Switch 2:

```
Switch1(config)# atm connection-traffic-table-row index 500 cbr pcr 10000
Switch1(config)# atm connection-traffic-table-row index 501 cbr pcr 10000
Switch1(config)# atm connection-traffic-table-row index 301 vbr-nrt pcr 2000 scr0 1640
Switch1(config)# atm connection-traffic-table-row index 302 vbr-nrt pcr 1500 scr0 1200
Switch1(config)# atm connection-traffic-table-row index 303 vbr-nrt pcr 400 scr0 350
Switch1(config)#
```

```
Switch1#
```

The following command confirms that the connection traffic table rows were created as needed for the ATM connection between Switch 1 and Switch 2:

```
Switch1# show atm connection-traffic-table
Row      Service-category    pcr        scr/mcr       mbs          cdvt    pd
.
.
.
301          vbr-nrt         2000        1640-0       none         none   off
302          vbr-nrt         1500        1200-0       none         none   off
303          vbr-nrt          400         350-0       none         none   off
500          cbr            10000                                  none   off
501          cbr            10000                                  none   off
```

The following commands configure the hierarchical tunnel service categories needed for the ATM connection between Switch 1 and Switch 2:

```
Switch1(config)# interface atm 0/1/1
Switch1(config-if)# description OC-3 at Switch1
Switch1(config-if)# atm pvp 10 hierarchical rx-cttr 500 tx-cttr 500
Switch1(config-if)# atm pvp 11 hierarchical rx-cttr 501 tx-cttr 501
Switch1(config-if)# end
Switch1#
```

The following command confirms that the hierarchical tunnel service was configured on the ATM connection between Switch 1 and Switch 2:

```
Switch1#show run interface atm 0/1/1
Building configuration...

Current configuration : 193 bytes
!
interface ATM0/1/1
 description OC-3 at Switch1
 no ip address
 no ip route-cache cef
 atm pvp 10 hierarchical rx-cttr 500 tx-cttr 500
 atm pvp 11 hierarchical rx-cttr 501 tx-cttr 501
end

Switch1#
```

Creating PVCs and Configuring VC Bundle on Enhanced ATM Router Module

This section describes creating the PVCs and configuring the VC bundle on the enhanced ATM router module.

To configure the VC bundle, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card/subcard/port.subinterface#* **multipoint** Switch(config-subif)#	Creates the ATM Router Module point-to-multipoint subinterface and enters subinterface mode.
Step 2	Switch(config-subif)# **ip address** *ip-address mask*	Provides a protocol address and subnet mask for the client on this subinterface.

	Command	Purpose
Step 3	Switch(config-subif)# **bundle** *name* Switch(config-if-atm-bundle)#	Creates the VC bundle changes to VC bundle configuration mode.
Step 4	Switch(config-if-atm-bundle)# **protocol** {*ip-address* | **ip** *ip-address* | **ipx** *ipx-address* | **inarp**} [[**no**] **broadcast**]	Configures the VC bundle protocol.
Step 5	Switch(config-if-atm-bundle)# **oam-bundle manage** *frequency-seconds*	Enables end-to-end F5 OAM loopback cell generation and OAM management for all VCs in the VC bundle.
Step 6	Switch(config-if-atm-bundle)# **pvc-bundle** *vpi vci* **interface atm** *card/subcard/port vpi vci* [**upc** {**tag** | **drop** | **pass**}] [**pd** {**on** | **off** | **use-cttr**}] [**rx-cttr** *rx-row*] [**tx-cttr** *tx-row*] [**wrr-weight** *value*] Switch(config-if-atm-member)#	Configures the VC bundle member and changes to VC bundle member configuration mode.
Step 7	Switch(config-if-atm-member)# **precedence** {**other** | *range*}	Configures the precedence level associated with the VC bundle member.
Step 8	Switch(config-if-atm-member)# **bump** {**implicit** | **explicit** *precedence-level* | **traffic**}	Configures the bumping rules (switching if a VC fails) for a specific VC bundle member.
Step 9	Switch(config-if-atm-member)# **protect** {**group** | **vc**}	Configures the VC to belong to a protected group or to be individually protected.
Step 10	Switch(config-if-atm-member)# **exit** Switch(config-if-atm-bundle)#	Exits back to VC bundle configuration mode to configure another PVC in the bundle.

The following example configures eight PVCs as members of a VC bundle named *Connection to Switch2*.

```
Switch(config)# interface atm 9/0/0.1 multipoint
Switch(config-subif)# description Connection to Switch2
Switch(config-subif)# ip address 3.0.0.1 255.0.0.0
Switch(config-subif)# bundle cisco
Switch(config-if-atm-bundle)# protocol ip inarp
Switch(config-if-atm-bundle)# oam-bundle manage broadcast
Switch(config-if-atm-bundle)# pvc-bundle 2 200 pd on wrr-weight 2 rx-cttr 301 tx-cttr 301 interface atm
0/0/0.1 2 300
Switch(config-if-atm-member)# precedence 3, 5-7
Switch(config-if-atm-member)# pvc-bundle 2 201 pd on wrr-weight 2 rx-cttr 302 tx-cttr 302 interface atm
0/0/0.1 2 301
Switch(config-if-atm-member)# precedence 4
Switch(config-if-atm-member)# pvc-bundle 2 202 pd on wrr-weight 2 rx-cttr 303 tx-cttr 303 interface atm
0/0/0.1 2 302
Switch(config-if-atm-member)# precedence 2
Switch(config-if-atm-member)# pvc-bundle 2 203 pd on interface atm 0/0/0.1 2 303

Switch(config-if-atm-member)# exit
Switch(config-if-atm-bundle)#
```

Calculating the Scheduler Class Weights

Scheduling is part of the per hop behavior and the scheduler is the mechanism that ultimately provides the QoS guarantees as it operates on the outgoing traffic.

There are eight scheduler classes available on the switch module controlling the enhanced ATM router module. These are labeled 1 to 8 and shown in Figure 25-12.

Figure 25-12 Current Scheduler Class Weight Diagram

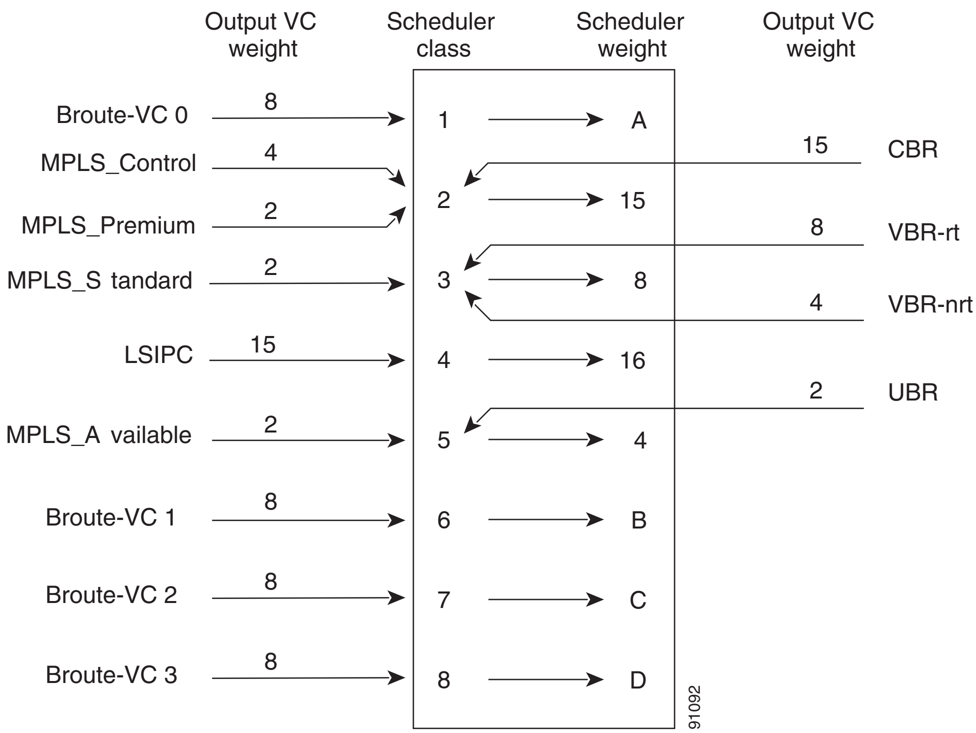


Figure 25-12 shows the mapping between the traffic types and the scheduler classes. The traffic classes of CBR, VBR, and UBR are mapped to scheduler classes 2, 3, and 5, respectively. The LSIPCs, which are internal control VCs, are mapped to scheduler class 4. That leaves four remaining scheduler classes for IP QoS traffic from other Layer 3 modules. Traffic from other Layer 3 modules is sent to the enhanced ATM router module via internal broute VC's. The four broute VCs each map to one of the remaining scheduler classes, as shown in Figure 25-12.

Note Only the broute VCs from XPIF based interface modules can terminate on the classes 1, 6, 7, and 8. IP QoS is not supported on EPIF based modules so, all broute VCs from EPIF based Fast Ethernet, Gigabit Ethernet, and the original ATM route module go to scheduler class 4 only.

The broute VC 0 maps to class-default traffic and goes to scheduler class 1. The other broute VCs correspond to non-default classes and can map to any scheduler class among 6, 7, and 8. The four broute VCs with scheduler classes 1, 6, 7, and 8 correspond to the maximum of four output policy maps that can be configured per interface, one of which must be the default.

The priority among the scheduler classes is decided by the weights assigned to the classes. The class with the highest weight is serviced more often than other classes, thereby offering differential service.

Because the enhanced ATM router module must schedule traffic received from both ATM VCs and Layer 3 (broute) VCs, one half of the bandwidth is reserved for ATM connections. The bandwidth configured on the maximum of four output policy maps must not be greater than 500 Mbps. Even if the sum of bandwidths is more than 500 Mbps (but not more than 1Gbps) the weights calculated for IP QoS classes is reserved for 500 Mbps maximum. The rest of the configured bandwidth is available only if there is no ATM traffic (which also includes Layer 3 traffic of scheduler class 4 from EPIF modules).

The following formula is used to calculate the scheduler class weights for the IP QoS classes after an IP QoS output policy is configured:

$$\text{Weight}_A = \frac{\text{Bandwidth configured for class-map}_A}{\Sigma\ \text{Bandwidth of all class-maps} + 500} * 255$$

In the formula, the weights are scaled to 255, because that is the maximum weight that can be configured for any scheduler-class.

The **show epc ip-atm-qos** command displays the mapping between the class maps and scheduler classes.

For example, using the following formula, class voice has a bandwidth of 200 Mbps, the total being 500 Mbps and the weight is calculated as 51.

Weight (class voice) = 255 * (200Mbps/(500Mps + 500Mps))

Weight = 51

This weight is assigned to scheduler class 8 (displayed using the **show epc ip-atm-qos** command.)

Next you must go back and calculate the minimum guaranteed bandwidth provided based on the calculated scheduler weights using the following formula:

$$\text{(Bandwidth of scheduler class A)} = \frac{\text{Schedule weight of Scheduler-class-A}}{\Sigma\ \text{of scheduler-class weights 0-2 and 4-7}} * 255$$

Note In this formula, you can ignore scheduler-class 4 for LSIPC because it is for internal control traffic and it is negligible.

The following formula shows the calculation for the voice traffic (class voice) as 89.788 Mbps (90 Mbps).

$$\text{Bandwidth (class voice)} = \frac{51}{16 + 240 + 128 + 64 + 25 + 44 + 51} * \text{1Gbps}$$

Use the example configuration given in this document and shown in Figure 25-12. In this example, the weights assigned to each scheduler class and the bandwidth reserved for each class are calculated and shown in Table 25-1.

Table 25-1 Scheduler Class to Weight Calculation

Scheduler Class Number	Traffic Type	Scheduler-class Weight	Bandwidth on Enhanced ATM Router Module (Mbps)
1	Default IP traffic	16	28
2	CBR	240	423
3	VBR (RT and nRT)	128	225
4	LSIPC	255	—
5	UBR, and traffic from Ethernet ports that do not support IP QoS	64	113
6	Priority IP traffic	25	44
7	Video	44	77
8	Voice	51	90

The "active" scheduler-classes concept is very important. A scheduler-class is said to be "active" if there is traffic on that class. If there is no traffic on that class, then the bandwidth reserved for that class is used by other classes when sending traffic. So, the formula to calculate the bandwidth can be modified as follows:

$$\text{(Bandwidth of scheduler class A)} = \frac{\text{Schedule-class weight of Scheduler-class-A}}{\Sigma \text{ of all ``active'' scheduler-class weights}} * \text{1Gbps}$$

In this formula, notice that the bandwidth reserved for the four IP QoS classes (1, 6, 7, and 8) is approximately half of what is actually configured in the class-map (for example, voice traffic gets 90 when actually 200 is configured). This is because the available enhanced ATM router module bandwidth for IP QoS is considered to be 500 Mbps, not 1Gbps. This is because on the enhanced ATM router module ATM traffic must also be handled.

Another important concept is that the bandwidth reserved for a particular class, for example voice, (90Mbps in this case), is for all XPIF interfaces configured to send traffic to this enhanced ATM router module. Traffic from all XPIF interfaces is queued in this way on the enhanced ATM router module.

Finally, excessive traffic on a particular queue can hog the bandwidth if it has a high scheduler-class weight. For example, if the requirement for voice is only 1.2 Mbps, but it has been configured such that the scheduler weight allows 90 Mbps, that much voice traffic could be sent.

This explanation describes traffic coming from Ethernet and ATM interfaces into the enhanced ATM router module. When traffic leaves the enhanced ATM router module and is transmitted out of the OC-3 interface, all ATM guarantees are preserved by the switch fabric. For example, if traffic enters from the Ethernet interface and exits from OC-3 through the enhanced ATM router module, then there are two phases to this process. Phase 1, Ethernet-to-WRR and then, phase 2, the enhanced ATM router module sents the traffic as rate scheduled and WRR-to-OC-3.

So, if traffic exits from the enhanced ATM router module on a CBR PVC to the OC-3 interface, it is rate scheduled (which is similar to Strict Priority). The same is true for the SCR portion of the VBR traffic. The remaining traffic, such as UBR, is WRR scheduled as usual.

So, if only a 1.2Mbps VC is available for voice, then only that much should be sent from the Ethernet interface. If more traffic is sent, it will reach the enhanced ATM router module but, from the enhanced ATM router module to the OC-3 interface, the traffic is dropped due to the rate scheduling mechanism.

Also, notice that the weights shown for the ATM connections in Figure 25-12 are one sixteenth of the weights shown in Table 25-1. For example, in Figure 25-12, the CBR output VC weight is shown as 15, but in Table 25-1 the scheduler-class weight is shown as 240. This is because the weights maintained in the Cisco IOS are in the range 1-15, whereas the weights to be installed in the fabric are in the range 16-240. This means the weights are multiplied by 16 before being installed in the switch fabric.

Congestion Control

Congestion Control is the second part of per hop behavior. It is configured using output policy. The output policy operates only if the enhanced ATM router module is congested. Without congestion, all of the traffic entering the enhanced ATM router module is switched without drops. If congestion occurs, dropping can occur in two places. In the first case, when the enhanced ATM router module is congested from other Layer 3 interfaces, traffic going to the scheduler class with the lowest weight is dropped first. The traffic being dropped depends on the IP QoS output policy configured and if the class has higher bandwidth than the the other traffic. These classes experience fewer drops than other classes.

In the second case, when the ATM output is congested with excess traffic from the enhanced ATM router module, traffic is dropped based on the characteristics of the ATM PVCs and not on the IP QoS configuration.

If no drop policy is configured in the output policy for each class, the default is tail drop. Tail drop simply means that if there is congestion, the last packet received is the first packet dropped. This continues until congestion is alleviated.

The other option is to configure the XPIF based Random Early Detect (xRed). The xRED algorithm drops packets intelligently based on some probability. This helps bursty applications like TCP achieve optimum performance. xRED can be configured for each class-map in the output policy so each queue has xRED running individually.

Troubleshooting and Verifying the VC Bundling with IP and ATM QoS

To troubleshoot and verify the bundled VCs with IP and ATM QoS, use the following privileged EXEC commands:

Command	Purpose
show epc ipqos database interface *interface-type card/subcard/port* **input**	Displays the IP QoS manager database configuration.
show epc ipqos output *interface-type card/subcard/port*	Displays the output QoS configuration.
show epc ip-atm-qos interface atm *card/subcard/port*	Displays bandwidth and weights of the scheduler classes.
show epc vc-bundle {*bundle-name* | **interface atm** *card/subcard/port*}	Displays the bundle-ID to bundle-name mapping and precedence to VC mapping for a VC bundle.
show running-config	Displays the configuration information currently running.

The following command verifies the input policy on the Gigabit Ethernet interface:

```
Switch1# show epc ipqos database interface GigabitEthernet 11/0/0 input
            Input IP QoS Manager Database for GigabitEthernet11/0/0
            ------------------------------------------------------
 ACL Database Region Id : 0
             Label Information for Label Id : 0
             --------------------------------------------
 Direction     : IN
 Asic inuse    : TRUE
 Interface list
 --------------
    Interface Type   : HWIDB
    Interface Name : GigabitEthernet11/0/0
    ASIC If-index : 2062
 Policy Map Information
 -----------------------
    Policy Map name    : mark
        Class Id for this class    : 0
        Label Id for the policymap : 0
        Class Map name   : mark-voice
            Filter status : TRUE
            Filter Type   : Match IP NUM ACL
            Filter params : 150
         Action Type   : SET
            Type : IP Precedence    Value : 3
        Class Id for this class    : 1
        Label Id for the policymap : 0
        Class Map name   : mark-video
            Filter status : TRUE
            Filter Type   : Match IP NUM ACL
            Filter params : 151
         Action Type   : SET
            Type : IP Precedence    Value : 4
        Class Id for this class    : 2
        Label Id for the policymap : 0
        Class Map name   : video
            Filter status : TRUE
            Filter Type   : Match IP PRECEDENCE
            Filter params : 2 6
         Action Type   : SET
            Type : IP Precedence    Value : 2
        Class Id for this class    : 3
        Label Id for the policymap : 0
        Class Map name   : class-default
            Filter status : TRUE
            Filter Type   : Match Any
         Action Type   : SET
            Type : IP DSCP unchanged
Switch1#
```

The following command verifies the output policy on the ATM interface:

```
Switch1# show epc ipqos output interface atm 9/0/0
Policy Assigned       : TRUE     Initialized               : TRUE
Broute VCs Created    : TRUE     CoS Enabled               : TRUE
IPQOS HW interface Num: 8        Number of Assigned Classes: 3
MMC Port: 68        MSC ID: 4       Port num in MSC:0
Policy Name           : arm2-ph
Queue Class Class      Sched Wei/Pri Buff  Copied   Default  EPD   EFCI  Drop
      ID    Name                         From Def. Traffic              Policy
0     2     class-defa WRR   16      0      FALSE    TRUE    TRUE  TRUE  XRED
1     1     hipri      WRR   31      1      FALSE    FALSE   TRUE  TRUE  XRED
2     0     video      WRR   55      2      FALSE    FALSE   TRUE  TRUE  XRED
```

```
3      255              WRR   128     3      TRUE      FALSE   TRUE  TRUE  TAIL
4      255              WRR   255     4      TRUE      FALSE   TRUE  FALSE TAIL (IPC)

Switch1#
Also "show epc ipqos database int a9/0/0 output" can be used
```

The following command verifies the allocated bandwidth after applying the output policy:

```
Switch1# show epc ip-atm-qos interface atm 9/0/0
MMC Port: 68        MSC ID: 4       Port num in MSC:0

Service  Application                 WRR Weight       Bandwidth(Kbps)
 Class                           External  Internal Configured  Actual
-------------------------------------------------------------------------
1      class-default                   *    16       25000        28169
6      hipri                           *    25       100000       44014
7      video                           *    44       175000       77464
8      voice                           *    51       200000       89788
2      CBR                             15   240      0            422535
3      VBR-RT/VBR-NRT                  8    128      6394         225352
4      LSIPCs                          15   255
5      UBR/UBR+                        4    64       0            112676
------------------------------------------------------------------------
 * - External Weights for IPQoS is assigned through Bandwidth CLI
Switch1#
```

The following command verifies the VC bundle precedence mapping:

```
Switch1# show epc vc-bundle ph-jm
bundle map not present for bundle:ph-jm
Switch1#sh epc vc-bundle ph-bj
bundle located at address:79804
Precedence to VCD map
Precedence      VCD

0               203
1               203
2               202
3               200
4               201
5               200
6               200
7               200

Switch1#
```

The following **show running-config** command displays the entire configuration of Switch1 as shown in Figure 25-11:

```
Switch1# show running-config
Building configuration...

Current configuration : 6469 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch1
!
boot config bootflash:cleanconfig
boot bootldr bootflash:cat8540m-wp-mz.121-10.EY
```

```
no logging buffered
enable password lab
!
username all
spd headroom 1024
facility-alarm core-temperature major 60
facility-alarm core-temperature minor 50
redundancy
 main-cpu
  sync dynamic-info
  sync config startup
  sync config running
sdm ipqos 512
sdm policy 0
no ip subnet-zero
no ip domain-lookup
!
ip multicast-routing
!
class-map match-all hipri
  match ip precedence 2
class-map match-all ABC-signaling-host
  match access-group 101
class-map match-all ABC-signaling-anyhost
  match access-group 100
class-map match-all mark-video
  match access-group 151
class-map match-all mark-voice
  match access-group 150
class-map match-all QPM_3.5Mb-30V-2VC
  match ip precedence 5 6 7
class-map match-all video
  match ip precedence 4
class-map match-all voice
  match ip precedence 3 5 6 7
!
!
policy-map mark
  class mark-voice
    set ip precedence 5
  class mark-video
    set ip precedence 4
policy-map ABC-signaling-mark
  class ABC-signaling-host
    set ip precedence 3

policy-map arm2-ph
  class voice
    bandwidth   200000

    random-detect buffer-group 3 max-probability 100 freeze-time 15

  class video
    bandwidth   175000

    random-detect buffer-group 2 max-probability 100 freeze-time 15

  class hipri
    bandwidth   100000

    random-detect buffer-group 1 max-probability 100 freeze-time 15

  class class-default
    bandwidth   25000
```

```
    random-detect buffer-group 0 max-probability 100 freeze-time 15

!
!
atm hierarchical-tunnel
atm connection-traffic-table-row index 101 vbr-nrt pcr 81 scr0 81  mbs 0
atm connection-traffic-table-row index 300 cbr pcr 2310  packet-discard
atm connection-traffic-table-row index 301 vbr-nrt pcr 2000 scr10 1640  packet-discard
atm connection-traffic-table-row index 302 vbr-nrt pcr 1500 scr10 1200  packet-discard
atm connection-traffic-table-row index 303 vbr-nrt pcr 400 scr10 350  packet-discard
atm connection-traffic-table-row index 500 cbr pcr 9000  packet-discard
atm connection-traffic-table-row index 501 cbr pcr 10000  packet-discard
atm connection-traffic-table-row index 1073741823 cbr pcr 10000
atm address 47.0091.8100.0000.0002.fdf3.9b01.0002.fdf3.9b01.00
atm address 47.0091.8100.0000.aaaa.bbbb.cccc.0010.7bc5.d301.00
atm router pnni
 no aesa embedded-number left-justified
 node 1 level 56 lowest
  redistribute atm-static
!
!
!
!
interface ATM0/0/0
 description OC-3 at PH
 no ip address
 load-interval 30
 atm pvp 10 hierarchical rx-cttr 500 tx-cttr 500
 atm pvp 11 hierarchical rx-cttr 501 tx-cttr 501
!
interface ATM0/0/0.10 point-to-point
 description ATM tunnel to BJ
!
interface ATM0/0/0.11 point-to-point
 description ATM tunnel to JM
!
interface ATM0/0/1
 no ip address
!
interface ATM0/0/2
 no ip address
!
interface ATM0/0/3
 no ip address
!
interface ATM0/1/0
 no ip address
!
interface ATM0/1/1
 no ip address
!
interface ATM0/1/2
 no ip address
!
interface ATM0/1/3
 no ip address
!
interface GigabitEthernet2/0/0
 description dummy
 ip address 34.0.0.1 255.0.0.0
 no cdp enable
!
interface ATM2/0/1
```

```
 no ip address
!
interface ATM0
 no ip address
 logging event subif-link-status
!
interface Ethernet0
 ip address 9.8.6.3 255.255.0.0
!
interface ATM9/0/0
 description ARM2 at PH
 no ip address
 service-policy output arm2-ph
!
interface ATM9/0/0.1 multipoint
 description Connection to BJ
 ip address 1.0.0.2 255.0.0.0
 bundle ph-bj
  protocol ip inarp broadcast
  pvc-bundle 2 200 pd on wrr-weight 2 rx-cttr 301 tx-cttr 301  interface  ATM0/0/0.10 10 
200
   precedence 3, 5-7
  pvc-bundle 2 201 pd on wrr-weight 2 rx-cttr 302 tx-cttr 302  interface  ATM0/0/0.10 10 
201
   precedence 4
  pvc-bundle 2 202 pd on wrr-weight 2 rx-cttr 303 tx-cttr 303  interface  ATM0/0/0.10 10 
202
   precedence 2
  pvc-bundle 2 203 pd on  interface  ATM0/0/0.10 10 203
   precedence other
 !
!
interface ATM9/0/0.2 multipoint
 description Connection to JM
 ip address 3.0.0.1 255.0.0.0
 bundle ph-jm
  protocol ip inarp broadcast
  pvc-bundle 2 300 pd on wrr-weight 2 rx-cttr 301 tx-cttr 301  interface  ATM0/0/0.11 11 
300
   precedence 3, 5-7
  pvc-bundle 2 301 pd on wrr-weight 2 rx-cttr 302 tx-cttr 302  interface  ATM0/0/0.11 11 
301
   precedence 4
  pvc-bundle 2 302 pd on wrr-weight 2 rx-cttr 303 tx-cttr 303  interface  ATM0/0/0.11 11 
302
   precedence 2
  pvc-bundle 2 303 pd on  interface  ATM0/0/0.11 11 303
   precedence other
 !
!
interface ATM9/0/1
 no ip address
!
interface ATM9/0/1.3 multipoint
 description dummy
 ip address 33.0.0.1 255.0.0.0
 atm pvc 2 4000 pd on  encap aal5snap inarp 1 interface  ATM0/0/0.11 11 4000
!
interface GigabitEthernet11/0/0
 description XPIF at PH
 ip address 50.0.0.1 255.0.0.0
 service-policy input mark
 service-policy input ABC-signaling-mark
 no cdp enable
```

```
!
interface GigabitEthernet11/0/1
 no ip address
!
router eigrp 100
 network 1.0.0.0
 network 3.0.0.0
 network 6.0.0.0
 network 8.0.0.0
 network 11.0.0.0
 network 33.0.0.0
 network 34.0.0.0
 network 50.0.0.0
 auto-summary
 no eigrp log-neighbor-changes
!
ip classless
ip route 13.0.0.0 255.0.0.0 3.0.0.10
no ip http server
!
!
!
map-list xyz
 ip 3.0.0.2 atm-vc 2000 broadcast
 ip 3.0.0.10 atm-vc 2001 broadcast
!
map-list xyy
 ip 44.0.0.2 atm-vc 3000 broadcast
access-list 100 permit udp any any eq 2556
access-list 101 permit udp 7.0.0.0 0.0.0.255 any eq 2556
access-list 102 permit ip host 6.0.0.2 host 7.0.0.2
access-list 150 permit ip host 50.0.0.2 any
access-list 150 permit ip host 50.0.0.3 any
access-list 151 permit ip host 50.0.0.4 any
!
!
line con 0
 exec-timeout 0 0
 history size 100
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 length 0
!
end

Switch1#


voice-PH# show running-config
Building configuration...

Current configuration : 979 bytes
!
version 12.2
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname voice-PH
!
enable password lab
```

```
!
ip subnet-zero
!
!!
no voice hpi capture buffer
no voice hpi capture destination
!
!
!
interface FastEthernet0/0
 description Connection to PH XPIF thru bridge
 ip address 50.0.0.2 255.0.0.0
 duplex auto
 speed auto
 no cdp enable
!
ip classless
ip route 0.0.0.0 0.0.0.0 50.0.0.1
no ip http server
ip pim bidir-enable
!
!
no cdp run
call rsvp-sync
!
voice-port 1/0/0
!
voice-port 1/0/1
!
voice-port 1/1/0
!
voice-port 1/1/1
!
!
mgcp profile default
!
dial-peer voice 100 pots
 destination-pattern 100
 port 1/1/1
!
dial-peer voice 101 voip
 destination-pattern 1..
 session target ipv4:51.0.0.2
 codec g711ulaw
!
!
line con 0
line aux 0
line vty 0 4
 login
!
end

voice-PH#
```

The following **show running-config** command displays the entire configuration of Switch2 as shown in Figure 25-11:

```
Switch2# show running-config
Building configuration...

Current configuration : 6103 bytes
!
version 12.1
```

```
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch2
!
boot config bootflash:cleanconfig
boot bootldr bootflash:cat8540m-wp-mz.121-10.EY
no logging buffered
enable password lab
!
username all
spd headroom 1024
facility-alarm core-temperature major 60
facility-alarm core-temperature minor 50
redundancy
 main-cpu
  sync dynamic-info
  sync config startup
  sync config running
sdm sram Label 32768
sdm sram Tag-Cos 32768
sdm ipqos 512
sdm policy 0
no ip subnet-zero
no ip domain-lookup
!
ip multicast-routing
!
class-map match-all hipri
  match ip precedence 2
class-map match-all ABC-signaling-host
  match access-group 101
class-map match-all ABC-signaling-anyhost
  match access-group 100
class-map match-all lat1
  match access-group 102
class-map match-all mark-video
  match access-group 151
class-map match-all mark-voice
  match access-group 150
class-map match-all video
  match ip precedence 4
class-map match-all voice
  match ip precedence 3 5 6 7
!
!
policy-map mark
  class mark-voice
    set ip precedence 5
  class mark-video
    set ip precedence 4
policy-map lat1
  class lat1
    set ip precedence 5
    police 500000 1000 exceed-action set-prec-transmit 3
policy-map ABC-signaling-mark
  class ABC-signaling-host
    set ip precedence 3
policy-map arm2-jm
  class voice
    bandwidth   200000
```

```
    random-detect buffer-group 3 max-probability 100 freeze-time 15

  class video
    bandwidth   175000

    random-detect buffer-group 2 max-probability 100 freeze-time 15

  class hipri
    bandwidth   100000

    random-detect buffer-group 1 max-probability 100 freeze-time 15

  class class-default
    bandwidth   25000

    random-detect buffer-group 0 max-probability 100 freeze-time 15

!
!
atm hierarchical-tunnel
atm connection-traffic-table-row index 300 cbr pcr 2310  packet-discard
atm connection-traffic-table-row index 301 vbr-nrt pcr 2000 scr10 1640  packet-discard
atm connection-traffic-table-row index 302 vbr-nrt pcr 1500 scr10 1200  packet-discard
atm connection-traffic-table-row index 303 vbr-nrt pcr 400 scr10 350  packet-discard
atm connection-traffic-table-row index 500 cbr pcr 7000  packet-discard
atm connection-traffic-table-row index 501 cbr pcr 10000  packet-discard
atm connection-traffic-table-row index 503 cbr pcr 2000  packet-discard
atm address 47.0091.8100.0000.0002.fdf3.a701.0002.fdf3.a701.00
atm router pnni
 no aesa embedded-number left-justified
 node 1 level 56 lowest
  redistribute atm-static
!
!
bridge irb
!
!
interface Loopback0
 ip address 100.1.1.1 255.0.0.0
!
interface ATM0/0/0
 description OC-3 at JM
 no ip address
 atm pvp 10 hierarchical rx-cttr 500 tx-cttr 500
 atm pvp 11 hierarchical rx-cttr 501 tx-cttr 501
 atm pvp 12 hierarchical rx-cttr 500 tx-cttr 500
!
interface ATM0/0/0.10 point-to-point
 description ATM tunnel to CR
!
interface ATM0/0/0.11 point-to-point
 description ATM tunnel to PH
!
interface ATM0/0/1
 no ip address
!
interface ATM0/0/2
 no ip address
!
interface ATM0/0/3
 no ip address
!
interface ATM0/1/0
 no ip address
```

```
!
interface ATM0/1/1
 no ip address
!
interface ATM0/1/2
 no ip address
!
interface ATM0/1/3
 no ip address
!
interface ATM0
 no ip address
 logging event subif-link-status
!
interface Ethernet0
 ip address 9.8.6.14 255.255.0.0
!
interface ATM9/0/0
 description ARM2 at JM
 no ip address
 service-policy output arm2-jm
!
interface ATM9/0/0.1 multipoint
 description Connection to CR
 ip address 2.0.0.2 255.0.0.0
 bundle jm-cr
  protocol ip inarp broadcast
  pvc-bundle 2 200 pd on wrr-weight 2 rx-cttr 301 tx-cttr 301  interface  ATM0/0/0.10 10
200
   precedence 3, 5-7
  pvc-bundle 2 201 pd on wrr-weight 2 rx-cttr 302 tx-cttr 302  interface  ATM0/0/0.10 10
201
   precedence 4
  pvc-bundle 2 202 pd on wrr-weight 2 rx-cttr 303 tx-cttr 303  interface  ATM0/0/0.10 10
202
   precedence 2
  pvc-bundle 2 203 pd on  interface  ATM0/0/0.10 10 203
   precedence other
 !
!
interface ATM9/0/0.2 multipoint
 description Connection to PH
 ip address 3.0.0.2 255.0.0.0
 bundle jm-ph
  protocol ip inarp broadcast
  pvc-bundle 2 300 pd on wrr-weight 2 rx-cttr 301 tx-cttr 301  interface  ATM0/0/0.11 11
300
   precedence 3, 5-7
  pvc-bundle 2 301 pd on wrr-weight 2 rx-cttr 302 tx-cttr 302  interface  ATM0/0/0.11 11
301
   precedence 4
  pvc-bundle 2 302 pd on wrr-weight 2 rx-cttr 303 tx-cttr 303  interface  ATM0/0/0.11 11
302
   precedence 2
  pvc-bundle 2 303 pd on  interface  ATM0/0/0.11 11 303
   precedence other
 !
!
interface ATM9/0/0.10 point-to-point
!
interface ATM9/0/0.11 point-to-point
!
interface ATM9/0/1
 no ip address
```

```
!
interface ATM9/0/1.3 multipoint
 ip address 33.0.0.2 255.0.0.0
 atm pvc 2 4000 pd on  encap aal5snap inarp 1 interface  ATM0/0/0.11 11 4000
!
interface GigabitEthernet11/0/0
 description XPIF at JM
 ip address 51.0.0.1 255.0.0.0
 service-policy input mark
 service-policy input ABC-signaling-mark
 no cdp enable
!
interface GigabitEthernet11/0/1
 ip address 35.0.0.1 255.0.0.0
!
interface ATM12/0/0
 no ip address
 sonet ais-shut
 sonet threshold sf-ber 4
!
interface ATM12/0/1
 no ip address
 sonet ais-shut
 sonet threshold sf-ber 4
!
interface ATM12/0/2
 no ip address
 sonet ais-shut
 sonet threshold sf-ber 4
!
interface ATM12/0/3
 no ip address
 sonet ais-shut
 sonet threshold sf-ber 4
!
router eigrp 100
 network 2.0.0.0
 network 3.0.0.0
 network 7.0.0.0
 network 10.0.0.0
 network 33.0.0.0
 network 35.0.0.0
 network 51.0.0.0
 network 100.0.0.0
 auto-summary
 no eigrp log-neighbor-changes
!
ip classless
no ip http server
!
!
!
map-list xyz
 ip 3.0.0.1 atm-vc 2000 broadcast
access-list 100 permit udp any any eq 2556
access-list 101 permit udp 7.0.0.0 0.0.0.255 any eq 2556
access-list 102 permit ip host 6.0.0.2 host 7.0.0.2
access-list 102 permit ip host 7.7.7.7 any
access-list 150 permit ip host 51.0.0.2 any
access-list 150 permit ip host 51.0.0.3 any
access-list 151 permit ip host 51.0.0.4 any
arp 13.0.0.2 0090.8888.7777 ARPA
!
bridge 1 protocol ieee
```

```
 bridge 1 route ip
!
line con 0
 exec-timeout 0 0
 history size 100
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 length 0
!
end

Switch2#
```

CHAPTER 26

Managing Configuration Files, System Images, and Functional Images

This chapter describes some fundamental tasks you perform to maintain the configuration files, system images, and hardware functional images used by your ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

Check the information in the first sections of the chapter to determine if it applies to your installation. Also, familiarize yourself with the Cisco IOS File System section, as this describes new features in this release. If you are an experienced IOS user, you can skip the third section.

Configuring a Static IP Route

If you are managing the ATM switch router through an Ethernet interface or ATM subinterface on the multiservice route processor, and your management station or Trivial File Transfer Protocol (TFTP) server is on a different subnet than the ATM switch router, you must first configure a static IP route.

Caution Failure to configure a static IP route prior to installing the new image will result in a loss of remote administrative access to the ATM switch router. If this happens, you can regain access from a direct console connection, although this requires physical access to the console port.

To configure a static IP route, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **ip route** *prefix*[1] *mask*[2] **ethernet 0** | **atm 0**[.*subinterface#*]	Configures a static IP route on the Ethernet interface or ATM subinterface of the route processor.
Step 2	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Saves the configuration to NVRAM.

1. The IP route prefix of the remote network where the management station or TFTP server resides.
2. The subnet mask of the remote network where the management station or TFTP server resides.

Example

The following example shows how to configure an IP address on the main Ethernet port, then save the configuration.

```
Switch(config)# interface ethernet 0
Switch(config-if)# ip address 172.20.52.11 255.255.255.224
Switch(config-if)# end
Switch# copy system:running-config nvram:startup-config
```

Understanding the Cisco IOS File System

This release of the ATM switch router system software uses the Cisco IFS (IOS File System). With IFS, you now access files on a storage device by specifying a filename and the file system containing the file. The following old command, for example, accesses the running-config and startup-config files:

```
Switch# copy running-config startup-config
```

With IFS, you additionally specify the system containing the files using the syntax *filesystem***:***filename*. For example:

```
Switch# copy system:running-config nvram:startup-config
```

The syntax *filesystem***:***filename* is called the file URL. In addition, remote file systems (such as TFTP, FTP, and rcp) allow you to specify additional options in the file URL, such as username, password, remote host, and so on. This way, you can enter all the required information at once without having to respond to prompts.

With IFS, some show commands have been replaced with more commands. For example:

```
Switch# show running-config
```

has been replaced with the following command:

```
Switch# more system:running-config
```

For complete information on using file URLs and the new IFS commands and syntax, refer to the *Configuration Fundamentals Configuration Guide* and the *Configuration Fundamentals Command Reference* publications.

File Systems and Memory Devices

File systems on the ATM switch router include read-only memory (RAM, or system), Flash memory (such as bootflash and the Flash PC cards in slot0 and slot1), and remote file systems (such as TFTP or rcp servers).

You can use the **show file systems** privileged EXEC command to display the valid file systems on your ATM switch router.

Example

The following example shows the file systems on a Catalyst 8540 MSR:

```
Switch# show file systems
File Systems:

     Size(b)     Free(b)      Type  Flags  Prefixes
*   20578304     8984376     flash     rw   slot0: flash:
     7995392      118192     flash     rw   slot1:
     7602176      636256     flash     rw   bootflash:
           -           -   unknown     rw   rcsf:
           -           -    opaque     rw   null:
           -           -    opaque     rw   system:
           -           -   network     rw   tftp:
      520184      517855     nvram     rw   nvram:
           -           -   network     rw   rcp:
           -           -   network     rw   ftp:
     5242880           0    opaque     ro   atm-acct-ready:
     5242880     5242880    opaque     ro   atm-acct-active:
    20578304     5264212     flash     rw   sec-slot0:
           -           -     flash     rw   sec-slot1:
     7602176      641048     flash     rw   sec-bootflash:
      520184      517855     nvram     rw   sec-nvram:
           -           -     nvram     rw   sec-rcsf:
```

File System Tasks

Refer to the *Configuration Fundamentals Configuration Guide* for details on the following frequently performed tasks:

- Format flash memory on a new Flash PC card or on any Flash memory device that has locked blocks or failed sectors
- Manage files on file systems, including setting the default file system, listing files on a file system, deleting and recovering files, and so on.

Maintaining System Images and Configuration Files

The following sections list common tasks you perform to maintain system images and configuration files on your ATM switch router:

- Modifying, Downloading, and Maintaining Configuration Files, page 26-4
- Modifying, Downloading, and Maintaining System Images, page 26-4
- Rebooting and Specifying Startup Information, page 26-4
- Additional File Transfer Features, page 26-5

For detailed instructions on performing these tasks, refer to the *Configuration Fundamentals Configuration Guide*.

Modifying, Downloading, and Maintaining Configuration Files

The following are frequently performed tasks to maintain configuration files:

- Copy configuration files from the ATM switch router to a network server—You can copy files to a TFTP server or rcp server for backup purposes or to store alternative configurations.
- Copy configuration files from a network server to the ATM switch router—You can copy configuration files from a TFTP server or an rcp server to the running configuration or startup configuration of the ATM switch router to restore a configuration, to use a configuration from another device, or to ensure that you have the same configuration on several devices.
- Maintain configuration files larger than NVRAM—You can maintain configuration files larger than NVRAM by compressing them, storing them on Flash memory devices, or storing them on TFTP or rcp servers for downloading at system startup.
- Copy configuration files between different locations—You can copy configuration files from Flash memory to the startup or running configuration, copy configuration files between Flash memory devices, or copy a configuration file from a server to Flash memory.
- Reexecute the configuration commands in startup configuration or clear the configuration information.

Modifying, Downloading, and Maintaining System Images

The following are frequently performed tasks to maintain system image files:

- Copy images from Flash memory to a network server—You can store system images for backup or other purposes by copying them from a Flash memory device to a TFTP or rcp server.
- Copy images from a network server to Flash memory—You perform this procedure when upgrading your system image or functional image.
- Copy images between local Flash memory devices.

Rebooting and Specifying Startup Information

The following commonly performed tasks are used to reboot the ATM switch router and specify startup information:

- Modify the configuration register boot field—You use the configuration register boot field to specify whether the ATM switch router loads a system image, and where it obtains the system image, or whether the system image loads from ROM.
- Specify the system startup image—You can enter multiple **boot** commands in the startup configuration file or in the BOOT environment variable to provide main and alternative methods for loading a system image onto the ATM switch router.
- Specify the startup configuration file—You can configure the CONFIG_FILE environment variable to load the startup configuration file from NVRAM (the default), from a Flash memory device, or from a network server.

- Enter ROM monitor mode or manually load a system image from ROM monitor if a valid system image is not found or if the configuration file is corrupted.

Additional File Transfer Features

The following file configuration file transfer options are also available:

- Configure the ATM switch router as a TFTP server to provide other devices on the network with system images and configuration files.
- Configure the ATM switch router to use the remote copy protocol (rcp) and remote shell (rsh) protocol—With rsh you can execute commands remotely; with rcp, you can copy files to and from a file system residing on a remote host or network server.

Maintaining Functional Images (Catalyst 8540 MSR)

You can load functional images used by certain hardware controllers in the ATM switch router. This section describes the function and maintenance of functional image.

Understanding Functional Images (Catalyst 8540 MSR)

Functional images provide the low-level operating functionality for various hardware controllers. On hardware controllers with insystem programmable devices, such as field programmable gate arrays (FPGAs) and Erasable Programmable Logic Devices (EPLDs), the hardware functional images can be reprogrammed independently of loading the system image and without removing the devices from the controller.

On the ATM switch router, you can reprogram the functional images on the route processors, rommon, switch processors, switch processor feature cards, carrier modules, full-width modules, and network clock modules.

All new hardware is shipped with functional images preloaded. Loading a different functional image is required only when upgrading or downgrading functional image versions.

Loading Functional Images (Catalyst 8540 MSR)

You load a functional image in two steps:

Step 1 Copy the image to a Flash memory device (bootflash, slot0, or slot1). For instructions on copying files to a Flash memory device, refer to the *Configuration Fundamentals Configuration Guide*.

Step 2 Load the image from the Flash memory device to the hardware controller.

Note The command for loading functional images on the ATM switch router differs from that described in the Cisco IOS documentation.

To download a functional image from a Flash memory device to a hardware controller, use the following command in privileged EXEC mode:

Command	Purpose
reprogram *device***:***filename* {*slot* [*subcard*] | **rommon**}	Loads the functional image with the specified filename to a device.

The **reprogram** command checks the compatibility of the image for the selected card type before downloading the functional image. If you have specified a slot number without a subcard, the functional image is downloaded to the full-width module that occupies that slot.

Note After loading a new functional image on the primary route processor or on one of the switch processors, you must power-cycle the switch for the hardware to reconfigure itself with the new image.

Caution Do not interrupt the download procedure. Wait until it has finished before attempting any commands on the switch.

Example

The following example demonstrates loading the functional image fi_c8540_rp.B.3_91 from the Flash PC card in slot 0 to the controller for the route processor in slot 4.

```
Switch# reprogram slot0:fi_c8540_rp.B.3_91 4
```

Displaying the Functional Image Information (Catalyst 8540 MSR)

To display the functional image version in a hardware controller, use the following command in privileged EXEC mode:

Command	Purpose
show functional-image-info {**slot** *slot* | **subslot** *slot***/***subslot*}	Displays the functional image information.

Example

The following example shows the functional image information in the controller for the route processor module in slot 4:

```
Switch# show functional-image-info slot 4

Details for cpu Image on slot: 4

Functional Version of the FPGA Image: 4.8
 #Jtag-Distribution-Format-B
 #HardwareRequired: 100(3.0-19,4.0-19,5.0-19)
 #FunctionalVersion: 4.8
 #Sections: 1
 #Section1Format: MOTOROLA_EXORMAX

  Copyright (c) 1996-00 by cisco Systems, Inc.
```

```
  All rights reserved.
  generated by:       holliday
  on:                 Mon Mar  6 13:59:17 PST 2000
  using:              /vob/cougar/bin/jtag_script Version 1.13
  config file:        cpu.jcf

  Chain description:
  Part type Bits Config file
  10k50     10   ../cidrFpga2/max/cidr_fpga.ttf
  xcs4062   3    ../cubiFpga2/xil/cubi.bit
  xcs4062   3    ../cubiFpga2/xil/cubi.bit
  generic   2
  XC4005    3    /vob/cougar/custom/common/jtcfg/xil/jtcfg_r.bit
  Number devices             = 5
  Number of instruction bits = 21

  FPGA config file information:
  Bitgen date/time  Sum   File
  100/03/02 19:14:49 7068  ../cidrFpga2/max/cidr_fpga.ttf
  1999/04/15 18:46:32 36965 ../cubiFpga2/xil/cubi.bit
  1999/04/15 18:46:32 36965 ../cubiFpga2/xil/cubi.bit
  98/06/11 16:56:44 49904 /vob/cougar/custom/common/jtcfg/xil/jtcfg_r.bit
#End-Of-Header
```

Maintaining Functional Images (Catalyst 8510 MSR and LightStream 1010)

You can load functional images used by certain hardware controllers in the ATM switch router. This section describes the function and maintenance of functional images.

Note If your E1 interface module has a functional image version earlier than 2.4 installed, you must first install intermediate functional image version 2.4 prior to upgrading.

Similarly, functional image version 3.3 is the intermediate image for the DS3 interface module.

Understanding Functional Images (Catalyst 8510 MSR and LightStream 1010)

Functional images provide the low-level operating functionality for various hardware controllers. On hardware controllers with insystem programmable devices, such as Field Programmable Gate Arrays (FPGAs) and Erasable Programmable Logic Devices (EPLDs), the hardware functional images can be reprogrammed independently of loading the system image and without removing the devices from the controller.

Note You can currently reprogram the functional image on the channelized DS3 and channelized E1 Frame Relay port adapters.

All new hardware is shipped with functional images preloaded. Loading a different functional image is required only when upgrading or downgrading functional image versions.

Loading Functional Images (Catalyst 8510 MSR and LightStream 1010)

You load a functional image in two steps:

Step 1 Copy the image to a Flash memory device (bootflash, slot0, or slot1). For instructions on copying files to a Flash memory device, refer to the *Configuration Fundamentals Configuration Guide*.

Step 2 Load the image from the Flash memory device to the hardware controller.

Note The command for loading functional images on the ATM switch router differs from that described in the Cisco IOS documentation.

To download a functional image from a Flash memory device to a hardware controller, use the following command in privileged EXEC mode:

Command	Purpose
reprogram *device***:***filename* {*slot* [*subcard*] | **rommon**}	Loads the functional image with the specified filename to a device.

The **reprogram** command checks the compatibility of the image for the selected card type before downloading the functional image.

Caution Do not interrupt the download procedure. Wait until it has finished before attempting any commands on the switch.

Example

The following example demonstrates loading the functional image abr_tmp.exo from the Flash PC card in slot 0 to the controller in slot 0, subcard 1:

```
Switch# reprogram slot0:abr_tmp.exo 0 1
```

Displaying the Functional Image Information (Catalyst 8510 MSR and LightStream 1010)

To display the functional image version in a hardware controller, use the following command in privileged EXEC mode:

Command	Purpose
show functional-image-info {**slot** *slot* | **subslot** *slot***/***subcard*}	Displays the functional image information.

Example

The following example shows the functional image information for the module in slot 4, subcard 0:

```
Switch# show functional-image-info subslot 4/0
###HardwareRequired   : B8(3.2)
##FunctionalVersion  : 2.3
##Sections           : 1
##Section1Format     : BINARY, length = 303016
# PUMA-4CE1 Firmware image
# Firmware Image       : fi-c8510-4e1fr.2_3
#
# EPLD config file  : C85MS-4E1-FRRJ48.jcf
# Chain description:
# Part type   Bits  Config file
# EPM7256S    10    /cougar/custom/puma/pld/testbench/PROG_FILES/4CE1/PLD/DB/7256.pof
# EPM7064S    10    /cougar/custom/puma/pld/testbench/PROG_FILES/4CE1/PLD/DB/7064.pof
# EPM7064S    10    /cougar/custom/puma/pld/testbench/PROG_FILES/4CE1/PLD/MB/7064.pof
# Number devices    = 3
# Number of instruction bits = 30
#
# FPGA config file information:
###End-of-header
```

PNNI Migration Examples

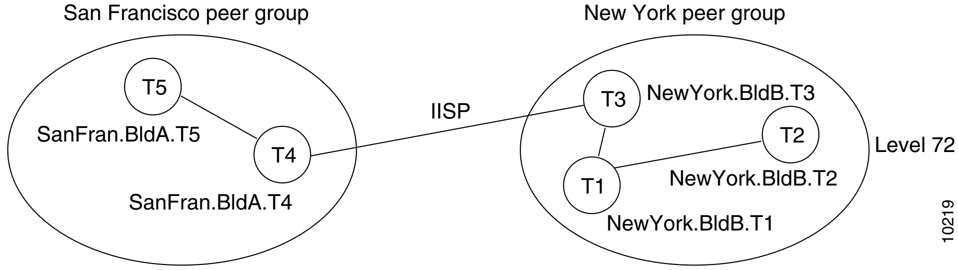
This appendix provides examples of how to migrate a flat network topology to a Private Network-Network Interface (PNNI) hierarchical network topology, and includes the following sections:

> **Note** Detailed PNNI configuration instructions are described in the chapter Chapter 11, "Configuring ATM Routing and PNNI." For a functional description of hierarchical PNNI, refer to the *Guide to ATM Technology*. For a complete description of the commands mentioned in this chapter, refer to the *ATM and Layer 3 Switch Router Command Reference* publication.

Adding a Higher Level of PNNI Hierarchy

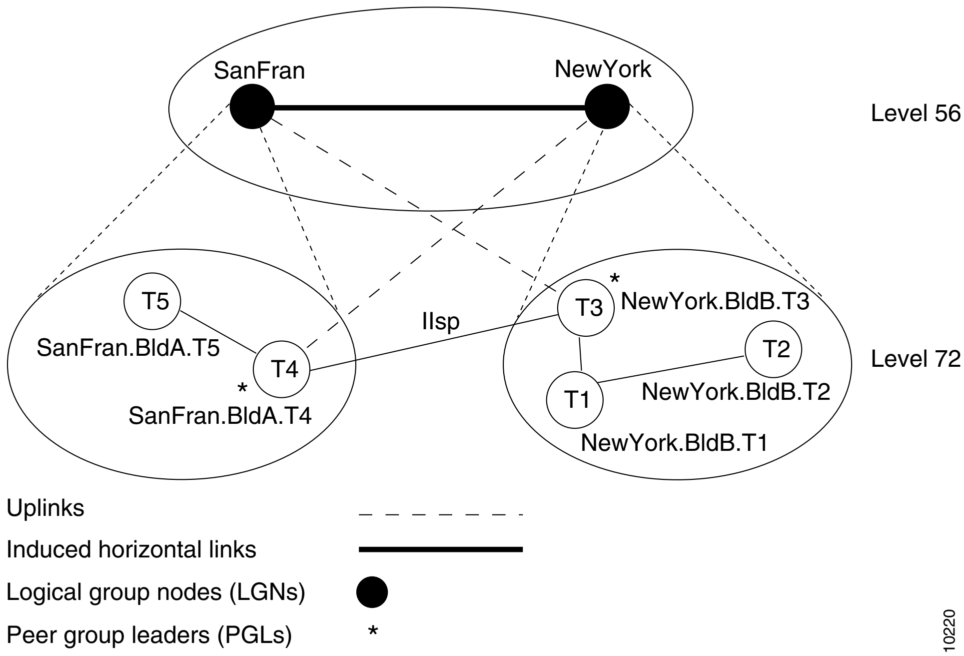
Figure A-1 shows an example network with two PNNI peer groups connected by an Interim Inter-Switch Signalling Protocol (IISP) interface.

Figure A-1 Two PNNI Peer Groups Connected by an IISP Interface



You can convert the network to a single hierarchical PNNI routing domain by configuring a second level of hierarchy in each peer group and converting the IISP interface to a PNNI interface, as shown in Figure A-2.

Figure A-2 Two-Level PNNI Hierarchical Network



The initial configuration for each ATM switch router is shown in the sections that follow. The commands used to migrate the network to a two-level PNNI hierarchical network (shown in Figure A-2) are also provided.

Switch T1 Initial Configuration

The initial configuration for switch NewYork BldB.T1 follows:

```
hostname NewYork.BldB.T1
atm address 47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a01.00
atm router pnni
 node 1 level 72 lowest
  redistribute atm-static
```

Switch T2 Initial Configuration

The initial configuration for switch NewYork BldB.T2 follows:

```
hostname NewYork.BldB.T2
atm address 47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01.00
atm router pnni
 node 1 level 72 lowest
  redistribute atm-static
```

To display the reachability information, use the **show atm route** command.

```
NewYork.BldB.T2# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 9   0            UP 0   47.0091.4455.6677.1144.1011.1233/104
P SI 1   0            UP 0   47.0091.4455.6677.1144.1011.1244/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc02/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.4000.0c/128
P  I 11  0            UP 0   47.0091.4455.6677.1144.1011.1255/104
P  E 11  0            UP 0   47.0091.4455.6677.22/64
S  E 1   ATM0/0/1     DN 0   47.0091.8200.0001.1/60
```

Switch T3 Initial Configuration

The initial configuration for switch NewYork BldB.T3 follows:

```
hostname NewYork.BldB.T3
atm address 47.0091.4455.6677.1144.1011.1255.0060.3e5b.c401.00
atm router pnni
 node 1 level 72 lowest
  redistribute atm-static

interface ATM0/0/2
 no ip address
atm route 47.0091.4455.6677.22... ATM0/0/2
```

To display the reachability information, use the **show atm route command**. To display the interface type, use the **show atm interface** command:

```
NewYork.BldB.T3# show atm interface atm 0/0/2

Interface:      ATM0/0/2        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    enabled         AutoCfgState:   completed
IF-Side:        Network         IF-type:        IISP
Uni-type:       not applicable  Uni-version:    V4.0

<information deleted>
```

Note In the example, the interface type of interface atm 0/0/2 on NewYork.BldB.T3 is determined using Integrated Local Management Interface (ILMI) autoconfiguration. Because the other side of the link on SanFran.BldA.T4 is configured as IISP, the interface type is determined to be IISP. When using ILMI autoconfiguration on one side of the link and manually configuring the other side as IISP, be careful to specify the configured side as either the user or network side, depending on whether it has the larger value of atmfMySystemIdentifier.

Switch T4 Initial Configuration

The initial configuration for switch SanFran.BldA.T4 follows:

```
hostname SanFran.BldA.T4
atm address 47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001.00
atm router pnni
 node 1 level 72 lowest
  redistribute atm-static

interface ATM0/0/3
 no ip address
 no atm auto-configuration
 atm iisp side user version 4.0
atm route 47.0091.4455.6677.11... ATM0/0/3
```

To display the reachability information, use the **show atm route command**. To display the interface type, side, and version, use the **show atm interface** command:

```
SanFran.BldA.T4# show atm interface atm 0/0/3

Interface:      ATM0/0/3        Port-type:      oc3suni
IF Status:      UP              Admin Status:   up
Auto-config:    disabled        AutoCfgState:   not applicable
IF-Side:        User            IF-type:        IISP
Uni-type:       not applicable  Uni-version:    V4.0
```

Switch T5 Initial Configuration

The initial configuration for switch SanFran.BldA.T5 follows:

```
hostname SanFran.BldA.T5
atm address 47.0091.4455.6677.2233.1011.1244.0060.3e7b.2401.00
atm router pnni
 node 1 level 72 lowest
  redistribute atm-static
```

Configuring Second Level of PNNI Hierarchy on Switches T3 and T4

The following example shows how to configure and display the second level of PNNI hierarchy on switches NewYork.BldB.T3 and SanFran.BldA.T4 (see Figure A-2):

Note In this example, the configuration of the second level of PNNI hierarchy on switch NewYork.BldB.T3 or switch SanFran.BldA.T4 has no effect on new or existing connections.

```
NewYork.BldB.T3# configure terminal
NewYork.BldB.T3(config)# atm router pnni
NewYork.BldB.T3(config-atm-router)# node 2 level 56
NewYork.BldB.T3(config-pnni-node)# name NewYork
NewYork.BldB.T3(config-pnni-node)# exit
NewYork.BldB.T3(config-atm-router)# node 1
NewYork.BldB.T3(config-pnni-node)# parent 2
NewYork.BldB.T3(config-pnni-node)# election leadership-priority 45
NewYork.BldB.T3(config-pnni-node)# end
NewYork.BldB.T3#
```

```
SanFran.BldA.T4# configure terminal
SanFran.BldA.T4(config)# atm router pnni
SanFran.BldA.T4(config-atm-router)# node 2 level 56
SanFran.BldA.T4(config-pnni-node)# name SanFran
SanFran.BldA.T4(config-pnni-node)# exit
SanFran.BldA.T4(config-atm-router)# node 1
SanFran.BldA.T4(config-pnni-node)# parent 2
SanFran.BldA.T4(config-pnni-node)# election leadership-priority 45
SanFran.BldA.T4(config-pnni-node)# end
SanFran.BldA.T4#
```

Use the following commands to confirm the creation of the PNNI hierarchy:

```
SanFran.BldA.T4# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T4
  System address          47.0091445566772233101112 66.00603E7B2001.01
  Node ID          72:160:47.00914455667722331011126 6.00603E7B2001.00
  Peer group ID        72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 45 95, No. of interfaces 3, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and running
  Node name: SanFran
  System address          47.00914455667722331011126 6.00603E7B2001.02
  Node ID           56:72:47.00914455667722330000000 0.00603E7B2001.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>

SanFran.BldA.T4# show atm pnni hierarchy
  Locally configured parent nodes:
  Node          Parent
  Index  Level  Index   Local-node Status     Node Name
  ~~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~
  1      72     2       Enabled/ Running      SanFran.BldA.T4
  2      56     N/A     Enabled/ Running      SanFran

SanFran.BldA.T4# show atm pnni hierarchy network
  Summary of active parent LGNs in the routing domain:
  Node  Level  Parent  Node Name
  ~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1     72     2       SanFran.BldA.T4
  2     56     0       SanFran

SanFran.BldA.T4# show atm pnni hierarchy network detail
  Detailed hierarchy network display:
  Number Of Network LGN Ancestors: 1

  Lowest Level (72) information:
  Node No.....: 1    Node Name: SanFran.BldA.T4
  Node's ID...:   72:160:47.00914455667722331011126 6.00603E7B2001.00
  Node's Addr.:          47.00914455667722331011126 6.00603E7B2001.01
  Node's PG ID:       72:47.0091.4455.6677.2233.0000.0000
  PGL No......: 1    PGL Name: SanFran.BldA.T4
  PGL ID......:   72:160:47.00914455667722331011126 6.00603E7B2001.00
```

```
Level 56 ancestor information:
Parent LGN..: 2    LGN Name: SanFran
LGN's ID....:    56:72:47.00914455667722330000000.00603E7B2001.00
LGN's Addr..:          47.00914455667722331011266.00603E7B2001.02
LGN's PG ID.:       56:47.0091.4455.6677.0000.0000.0000
LGN PGL No..:      Unelected or unknown
LGN's PGL ID:      0:0:00.000000000000000000000000.000000000000.00
```

Configuring the Link Between Switch T3 and Switch T4 for PNNI

The following example shows how to configure the link between switch NewYorkBldB.T3 and SanFran.BldA.T4 for PNNI.

Note In this example, only one side of the IISP interface is configured to change the link from IISP to PNNI because the other side of the link is using ILMI autoconfiguration for the interface type. You can use either the **atm auto-configuration** or **atm nni** command to change the link from IISP to PNNI.

```
SanFran.BldA.T4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T4(config)# interface atm 0/0/3
SanFran.BldA.T4(config-if)# atm auto-configuration
SanFran.BldA.T4(config-if)# end
SanFran.BldA.T4#
%ATM-5-ATMSOFTSTART: Restarting ATM signalling and ILMI on ATM0/0/3.
```

Note When you change the link from IISP to PNNI, all existing connections across the interface are cleared. The ability to route new connections across the link is restored within a few seconds, when the PNNI uplinks and induced horizontal link come up.

Verifying Connectivity to All ATM Addresses and Deleting an Old Static Route on Switches T4 and T3

The following example shows how to verify connectivity to all ATM addresses before deleting an old static route on switch T4:

```
SanFran.BldA.T4# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E 1   ATM0/0/3     DN 0   47.0091.4455.6677.11/64
P  I 12  0            UP 0   47.0091.4455.6677.1144/72
P SI 2   0            UP 0   47.0091.4455.6677.2233/72
P  I 9   0            UP 0   47.0091.4455.6677.2233.1011.1244/104
P SI 1   0            UP 0   47.0091.4455.6677.2233.1011.1266/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2002/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.4000.0c/128
```

The following example shows how to delete the old static route from switch T4:

```
SanFran.BldA.T4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T4(config)# no atm route 47.0091.4455.6677.11 atm0/0/3
SanFran.BldA.T4(config)# end
SanFran.BldA.T4#
```

The following example verifies that the old static route on switch T4 has been deleted:

```
SanFran.BldA.T4# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 12   0           UP 0   47.0091.4455.6677.1144/72
P SI 2    0           UP 0   47.0091.4455.6677.2233/72
P  I 9    0           UP 0   47.0091.4455.6677.2233.1011.1244/104
P SI 1    0           UP 0   47.0091.4455.6677.2233.1011.1266/104
R  I 1    ATM2/0/0    UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001/152
R  I 1    ATM2/0/0    UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2002/152
R  I 1    ATM2/0/0    UP 0   47.0091.4455.6677.2233.1011.1266.4000.0c/128
```

The following example shows how to delete the old static route from switch T3:

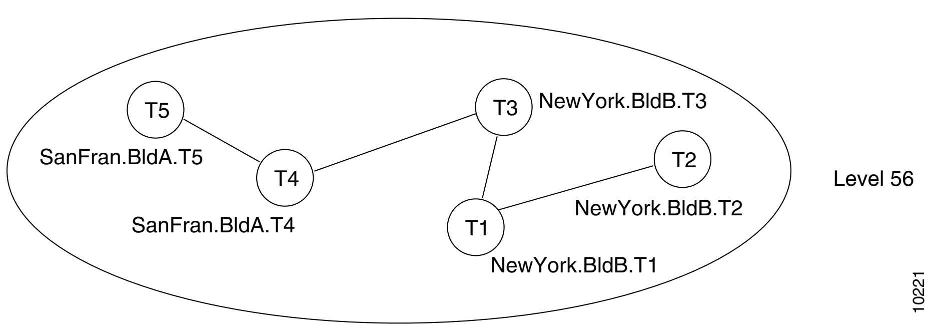
```
NewYork.BldB.T3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NewYork.BldB.T3(config)# no atm route 47.0091.4455.6677.22 atm 0/0/2
NewYork.BldB.T3(config)# end
NewYork.BldB.T3#
```

To verify the deletion of the old static route on switch T3, use the **show atm route** command.

Adding a New Lowest Level of PNNI Hierarchy

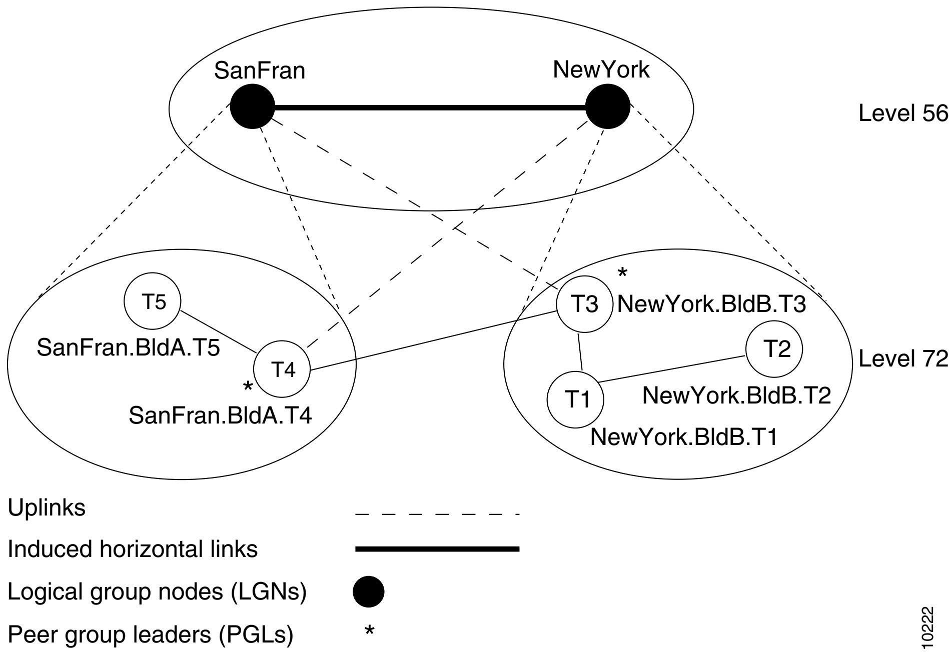
Figure A-3 shows an example network configured with only one level of PNNI hierarchy at level 56.

Figure A-3 One-Level PNNI Hierarchical Network



You can convert the network into a two-level hierarchical PNNI network by bringing each lowest level node down to level 72 and splitting the network into two peer groups. At the same time, you can add a second level of hierarchy at level 56. The resulting network topology is shown in Figure A-4.

Figure A-4 Two-Level PNNI Hierarchical Network



Note This example assumes that all addresses have already been assigned according to a hierarchical ATM address plan. All the ATM switch routers share the same 56-bit prefix. The ATM switch routers in Building A in San Francisco share the same 72-bit prefix. The ATM switch routers in Building B in New York share a different 72-bit prefix. As a result, no renumbering is necessary to migrate the network from a single level of PNNI hierarchy to two levels of PNNI hierarchy.

Note If no renumbering is necessary and all ATM switch routers are peer group leader/logical group node (PGL/LGN)-capable (Cisco IOS Release 11.3T, WA4, or later releases), existing connections are not affected by the migration process. The existing connections remain active while you modify the PNNI configuration.

You can implement the migration process one ATM switch router at a time. As each ATM switch router is moved down to level 72, the ability to establish new connections across that ATM switch router is lost temporarily and then automatically restored. You can pause for long periods of time during the migration process without any harmful effects.

The initial configuration for each ATM switch router is shown in the sections that follow. The commands used to migrate the network to the two-level PNNI hierarchical network (shown in Figure A-4) are also provided.

Switch T1 Initial Configuration

The initial configuration for switch NewYork BldB.T1 follows:

```
hostname NewYork.BldB.T1
atm address 47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a01.00
atm router pnni
 node 1 level 56 lowest
  redistribute atm-static
```

The following example shows the output from the **show atm route** command for the switch:

```
NewYork.BldB.T1# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P SI 1   0            UP 0   47.0091.4455.6677.1144.1011.1233/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a01/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a02/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a03/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a04/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a05/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1233.4000.0c/128
P  I 9   0            UP 0   47.0091.4455.6677.1144.1011.1244/104
P  I 10  0            UP 0   47.0091.4455.6677.1144.1011.1255/104
P  I 12  0            UP 0   47.0091.4455.6677.2233.1011.1244/104
P  I 11  0            UP 0   47.0091.4455.6677.2233.1011.1266/104
```

Switch T2 Initial Configuration

The initial configuration for switch NewYork BldB.T2 follows:

```
hostname NewYork.BldB.T2
atm address 47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01.00
atm router pnni
 node 1 level 56 lowest
  redistribute atm-static
```

Switch T3 Initial Configuration

The initial configuration for switch NewYork BldB.T3 follows:

```
hostname NewYork.BldB.T3
atm address 47.0091.4455.6677.1144.1011.1255.0060.3e5b.c401.00
atm router pnni
 node 1 level 56 lowest
  redistribute atm-static
```

Switch T4 Initial Configuration

The initial configuration for switch SanFran.BldA.T4 follows:

```
hostname SanFran.BldA.T4
atm address 47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001.00
atm router pnni
 node 1 level 56 lowest
  redistribute atm-static
```

Switch T5 Initial Configuration

The initial configuration for switch SanFran.BldA.T5 follows:

```
hostname SanFran.BldA.T5
atm address 47.0091.4455.6677.2233.1011.1244.0060.3e7b.2401.00
atm router pnni
 node 1 level 56 lowest
  redistribute atm-static
```

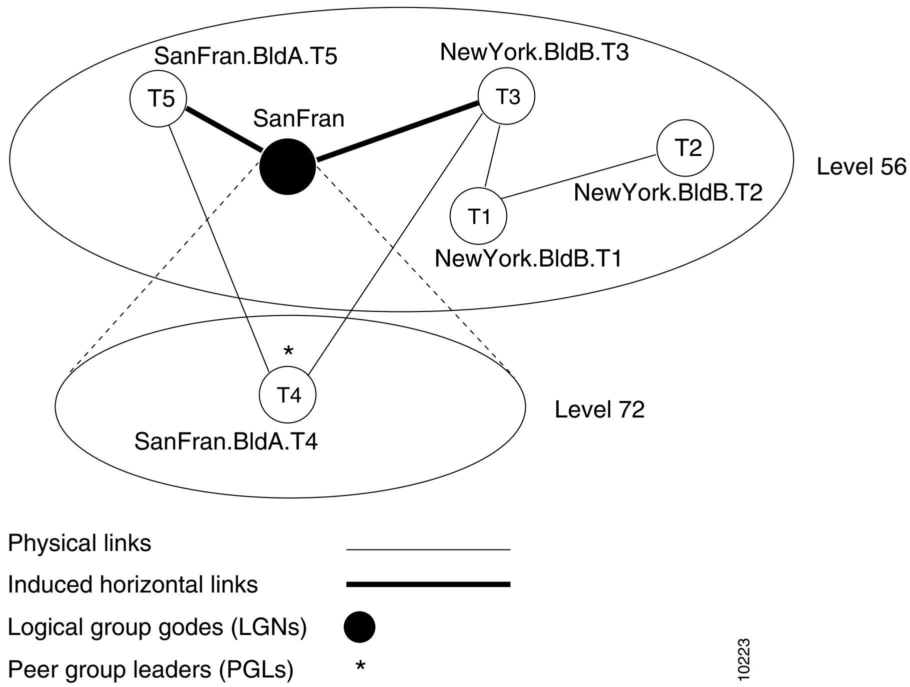
Moving Switch T4 Down into a New Peer Group

The first ATM switch router you move down into a new peer group at level 72 should be the ATM switch router you prefer as the peer group leader (PGL). Before moving down the first ATM switch router, configure the logical group node (LGN) for the second level of hierarchy on the ATM switch router.

Note We recommend that you enter the **no auto-summary** command to disable **auto-summary** on all new LGNs during the migration process. PNNI always routes to the node that advertises the longest matching reachable address prefix; therefore, auto-summary is not required. Furthermore, debugging is easier when **auto-summary** is disabled. If anything goes wrong during the migration process, you can use the **show atm route** command to debug the problem. After all the nodes have been moved into the child peer group represented by the LGN, restore **auto-summary** to reduce the number of reachable address prefixes advertised by the LGN.

Figure A-5 shows the network topology after moving ATM switch router SanFran.BldA.T4 down into a new peer group at level 72 and establishing an LGN representing that peer group at level 56.

Figure A-5 Moving a Switch Down in the PNNI Hierarchy



Although ATM switch router SanFran.BldA.T5 and NewYork.BldB.T3 are not running any PGLs or LGNs in this example, these ATM switch routers must be capable of establishing the PNNI hierarchy. This capability allows them to bring up the induced horizontal links to the LGN SanFran, maintaining PNNI connectivity across the network. For this reason, we recommend that you upgrade all ATM switch routers to Cisco IOS Release 11.3T, WA4 or later, before configuring PNNI hierarchy.

The following example shows how to move switch SanFran.BldA.T4 down into a new peer group:

```
SanFran.BldA.T4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T4(config)# atm router pnni
SanFran.BldA.T4(config-atm-router)# node 2 level 56
SanFran.BldA.T4(config-pnni-node)# name SanFran
SanFran.BldA.T4(config-pnni-node)# no auto-summary
SanFran.BldA.T4(config-pnni-node)# exit
SanFran.BldA.T4(config-atm-router)# node 1
SanFran.BldA.T4(config-pnni-node)# election leadership-priority 45
SanFran.BldA.T4(config-pnni-node)# node 1 disable
SanFran.BldA.T4(config-pnni-node)# node 1 level 72
SanFran.BldA.T4(config-pnni-node)# parent 2
SanFran.BldA.T4(config-pnni-node)# node 1 enable
SanFran.BldA.T4(config-pnni-node)# end
SanFran.BldA.T4#
```

Note When you move down the first switch into a new peer group, the ATM switch router cannot establish new connections until it can elect itself PGL. By default, this election process takes approximately 90 seconds, or less if a second ATM switch router is brought into the peer group quickly. After the new configuration on this ATM switch router is stable, the PNNI network is fully functional and new connections can be accepted across all ATM switch routers.

Moving Switch SanFran.BldA.T5 Down into an Existing Peer Group

After you move the first ATM switch router down to form a new peer group, you can move the remaining ATM switch routers down into the peer group one by one. You should move the ATM switch routers down in an order that keeps the peer group contiguous.

The following example shows how to move switch SanFran.BldA.T5 down into a peer group at level 72:

```
SanFran.BldA.T5# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T5(config)# atm router pnni
SanFran.BldA.T5(config-atm-router)# node 1 disable
SanFran.BldA.T5(config-pnni-node)# node 1 level 72 enable
SanFran.BldA.T5(config-pnni-node)# end
SanFran.BldA.T5#
```

Note When you move an ATM switch router down into an existing peer group, the ability to establish new connections across that ATM switch router is lost temporarily (up to several seconds).

To verify the configuration, use the **show atm pnni local-node** and **show atm pnni hierarchy** commands. For examples of these commands, see Configuring Second Level of PNNI Hierarchy on Switches T3 and T4, page A-4.

You can configure one or more of the ATM switch routers that have been moved down into the peer group as a backup PGL. The following example shows how to configure SanFran.BldA.T5 as a backup PGL for the peer group SanFran (see Figure A-4):

```
SanFran.BldA.T5# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T5(config)# atm router pnni
SanFran.BldA.T5(config-atm-router)# node 2 level 56
SanFran.BldA.T5(config-pnni-node)# name SanFran
SanFran.BldA.T5(config-pnni-node)# no auto-summary
SanFran.BldA.T5(config-pnni-node)# exit
SanFran.BldA.T5(config-atm-router)# node 1
SanFran.BldA.T5(config-pnni-node)# election leadership-priority 10
SanFran.BldA.T5(config-pnni-node)# parent 2
SanFran.BldA.T5(config-pnni-node)# end
SanFran.BldA.T5#
SanFran.BldA.T5# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T5
  System address          47.00914455667722331011244.00603E7B2401.01
  Node ID          72:160:47.00914455667722331011244.00603E7B2401.00
  Peer group ID        72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 10 10, No. of interfaces 2, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and not running
  Node name: SanFran
  System address          47.00914455667722331011244.00603E7B2401.02
  Node ID           56:72:47.00914455667722330000000.00603E7B2401.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>
```

```
SanFran.BldA.T5# show atm pnni hierarchy
  Locally configured parent nodes:
  Node          Parent
  Index  Level  Index   Local-node Status     Node Name
  ~~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~
  1      72     2       Enabled/ Running      SanFran.BldA.T5
  2      56     N/A     Enabled/ Not Running  SanFran

SanFran.BldA.T5# show atm pnni hierarchy network
  Summary of active parent LGNs in the routing domain:
  Node  Level  Parent  Node Name
  ~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1     72     14      SanFran.BldA.T5
  14    56     0       SanFran
```

Restoring Auto-Summary on the LGN SanFran

After all the nodes destined for the new peer group migrate into the peer group, you can restore **auto-summary** to reduce the number of reachable address prefixes advertised by the LGN.

The following example shows how to enable **auto-summary** on the LGN SanFran:

```
SanFran.BldA.T5# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T5(config)# atm router pnni
SanFran.BldA.T5(config-atm-router)# node 2
SanFran.BldA.T5(config-pnni-node)# auto-summary
SanFran.BldA.T5(config-pnni-node)# end
SanFran.BldA.T5#
```

The following example shows how to verify the configuration:

```
SanFran.BldA.T5# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1   Int   N   Y    Y   47.0091.4455.6677.2233.1011.1244/104
  2   Int   N   Y    N   47.0091.4455.6677.2233/72
```

The switch that contains the active PGL is configured similarly:

```
SanFran.BldA.T4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SanFran.BldA.T4(config)# atm router pnni
SanFran.BldA.T4(config-atm-router)# node 2
SanFran.BldA.T4(config-pnni-node)# auto-summary
SanFran.BldA.T4(config-pnni-node)# end
SanFran.BldA.T4#
```

The following examples show how to verify the configuration:

```
SanFran.BldA.T4# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   1  Int   N   Y    Y   47.0091.4455.6677.2233.1011.1266/104
   2  Int   N   Y    Y   47.0091.4455.6677.2233/72

SanFran.BldA.T4# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 12  0            UP 0   47.0091.4455.6677.1144.1011.1233/104
P  I 11  0            UP 0   47.0091.4455.6677.1144.1011.1244/104
P  I 9   0            UP 0   47.0091.4455.6677.1144.1011.1255/104
P SI 2   0            UP 0   47.0091.4455.6677.2233/72
P  I 13  0            UP 0   47.0091.4455.6677.2233.1011.1244/104
P SI 1   0            UP 0   47.0091.4455.6677.2233.1011.1266/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.0060.3e7b.2002/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.2233.1011.1266.4000.0c/128
```

Moving Switches T3, T1, and T2 Down into a New Peer Group

The following example shows how to move switch NewYork.BldB.T3 down into a new peer group:

```
NewYork.BldB.T3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NewYork.BldB.T3(config)# atm router pnni
NewYork.BldB.T3(config-atm-router)# node 2 level 56
NewYork.BldB.T3(config-pnni-node)# name NewYork
NewYork.BldB.T3(config-pnni-node)# no auto-summary
NewYork.BldB.T3(config-pnni-node)# exit
NewYork.BldB.T3(config-atm-router)# node 1
NewYork.BldB.T3(config-pnni-node)# election leadership-priority 45
NewYork.BldB.T3(config-pnni-node)# node 1 disable
NewYork.BldB.T3(config-pnni-node)# node 1 level 72
NewYork.BldB.T3(config-pnni-node)# parent 2
NewYork.BldB.T3(config-pnni-node)# node 1 enable
NewYork.BldB.T3(config-pnni-node)# end
NewYork.BldB.T3#
```

The following example shows how to move switch NewYork.BldB.T1 down into a new peer group:

```
NewYork.BldB.T1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NewYork.BldB.T1(config)# atm router pnni
NewYork.BldB.T1(config-atm-router)# node 1 disable
NewYork.BldB.T1(config-pnni-node)# node 1 level 72 enable
NewYork.BldB.T1(config-pnni-node)# end
NewYork.BldB.T1#
```

The following example shows how to move switch NewYork.BldB.T2 down into a new peer group:

```
NewYork.BldB.T2# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NewYork.BldB.T2(config)# atm router pnni
NewYork.BldB.T2(config-atm-router)# node 1 disable
NewYork.BldB.T2(config-pnni-node)# node 1 level 72 enable
NewYork.BldB.T2(config-pnni-node)# end
NewYork.BldB.T2#
```

The following examples show how to verify the results of the configuration:

```
NewYork.BldB.T2# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T2
  System address          47.00914455667711441011124 4.00603E5BBC01.01
  Node ID          72:160:47.009144556677114410111244.00603E5BBC01.00
  Peer group ID        72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 0 0, No. of interfaces 3, No. of neighbors 1
  Parent Node Index: NONE

<information deleted>

NewYork.BldB.T2# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P  I 9   0            UP 0   47.0091.4455.6677.1144.1011.1233/104
P  I 13  0            UP 0   47.0091.4455.6677.1144.1011.1233/104
P SI 1   0            UP 0   47.0091.4455.6677.1144.1011.1244/104
P  I 13  0            UP 0   47.0091.4455.6677.1144.1011.1244/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc02/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1244.4000.0c/128
P  I 11  0            UP 0   47.0091.4455.6677.1144.1011.1255/104
P  I 13  0            UP 0   47.0091.4455.6677.1144.1011.1255/104
P  I 12  0            UP 0   47.0091.4455.6677.2233/72


NewYork.BldB.T2# show atm pnni hierarchy network
  Summary of active parent LGNs in the routing domain:
  Node  Level  Parent  Node Name
  ~~~~  ~~~~~  ~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1     72     13      NewYork.BldB.T2
  13    56     0       NewYork

NewYork.BldB.T2# show atm pnni hierarchy network detail
  Detailed hierarchy network display:
  Number Of Network LGN Ancestors: 1
```

```
  Lowest Level (72) information:
  Node No.....: 1    Node Name: NewYork.BldB.T2
  Node's ID...:   72:160:47.00914455667711441011244.00603E5BBC01.00
  Node's Addr.:          47.00914455667711441011244.00603E5BBC01.01
  Node's PG ID:       72:47.0091.4455.6677.1144.0000.0000
  PGL No......: 11   PGL Name: NewYork.BldB.T3
  PGL ID......:   72:160:47.00914455667711441011255.00603E5BC401.00

  Level 56 ancestor information:
  Parent LGN..: 13   LGN Name: NewYork
  LGN's ID....:    56:72:47.00914455667711440000000.00603E5BC401.00
  LGN's Addr..:          47.00914455667711441011255.00603E5BC401.02
  LGN's PG ID.:       56:47.0091.4455.6677.0000.0000.0000
  LGN PGL No..:      Unelected or unknown
  LGN's PGL ID:      0:0:00.000000000000000000000000.000000000000.00
```

Restoring Autosummary on the LGN NewYork

The following example shows how to restore autosummary on the LGN NewYork:

```
NewYork.BldB.T3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NewYork.BldB.T3(config)# atm router pnni
NewYork.BldB.T3(config-atm-router)# node 2
NewYork.BldB.T3(config-pnni-node)# auto-summary
NewYork.BldB.T3(config-pnni-node)# end
NewYork.BldB.T3#
```

The following examples show how to verify the configuration:

```
NewYork.BldB.T3# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1   Int   N   Y    Y   47.0091.4455.6677.1144.1011.1255/104
  2   Int   N   Y    Y   47.0091.4455.6677.1144/72

NewYork.BldB.T3# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
P SI 2   0            UP 0   47.0091.4455.6677.1144/72
P  I 12  0            UP 0   47.0091.4455.6677.1144.1011.1233/104
P  I 9   0            UP 0   47.0091.4455.6677.1144.1011.1244/104
P SI 1   0            UP 0   47.0091.4455.6677.1144.1011.1255/104
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1255.0060.3e5b.c401/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1255.0060.3e5b.c402/152
R  I 1   ATM2/0/0     UP 0   47.0091.4455.6677.1144.1011.1255.4000.0c/128
P  I 10  0            UP 0   47.0091.4455.6677.2233/72
```

APPENDIX B

Acronyms

The acronyms in this appendix apply to the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010. Table B-1 lists the acronyms used in this publication, along with their expansions.

Table B-1 List of Acronyms

Acronym	Definition
AAA	authentication, authorization, and accounting
AAL	ATM adaptation layer
ABR	available bit rate
ACK	acknowledge
AESA	ATM end system address
AIS	alarm indication signal
APS	automatic protection switching
AR	access rate
ARP	Address Resolution Protocol
ATM ARP	ATM Address Resolution Protocol
AW	administrative weight
Bc	committed burst size
Be	excess burst size
BER	bit error rate
BERT	bit error rate test
BITS	Building Integrated Timing Supply
BOOTP	Bootstrap Protocol
BUS	broadcast and unknown server
CAC	connection admission control
CAS	channel associated signalling
CBR	constant bit rate
CCO	Cisco Connection Online
CDP	Cisco Distribution Protocol
CDS3	channelized DS3

Table B-1 List of Acronyms (continued)

Acronym	Definition
CDV	cell delay variation
CDVT	cell delay variation tolerance
CE1	channelized E1
CES	circuit emulation services
CES-IWF	circuit emulation services interworking function
CHAP	Challenge Handshake Authentication Protocol
CIR	committed information rate
Cisco IFS	Cisco IOS File System
CLI	command-line interface
CLP	cell loss priority
CLR	cell loss ration
CoS	class of service
CRC	cyclic redundancy check
CSR	campus switch router
CTC	common transmit clocking
CTD	cell transfer delay
CTT	Connection Traffic Table
CTTR	Connection Traffic Table row
CUG	closed user group
DACS	digital access and crossconnect system
DCC	Data Country Code
DIP	dual in-line package
DLCI	data-link connection identifier
EFCI	Explicit Forward Congestion Indication
EHSA	Enhanced High System Availability
EIGRP	Enhanced Interior Gateway Routing Protocol
ELAN	emulated LAN
EPD	early packet discard
ESI	end system identifier
FC-PCQ	feature card per-class queuing
FC-PFQ	feature card per-flow queuing
FDL	facility data link
FE	Fast Ethernet
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
GE	Gigabit Ethernet

Table B-1 List of Acronyms (continued)

Acronym	Definition
ICD	International Code Designator
ICMP	International Control Message Protocol
ICP	IMA Control Protocol
ID	identifier
IE	information element
IISP	Interim Interswitch Signaling Protocol
ILMI	Integrated Local Management Interface
IMA	inverse multiplexing over ATM
InARP	Inverse ARP
IPSec	IP Security Protocol
IPX	Internet Packet Exchange
LANE	LAN emulation
LBO	line build-out
LCD	loss of cell delineation
LDP	Label Distribution Protocol
LEC	LAN emulation client
LECS	LAN emulation configuration server
LER	Label Edge Router
LES	LAN emulation server
LGN	logical group node
LIS	logical IP subnet
LMI	Local Management Interface
LOS	loss of signal
LSR	Label Switch Router
MaxCR	maximum cell rate
MBS	maximum burst size
MCR	minimum cell rate
MDL	maintenance data link
MMF	multimode fiber
MSR	multiservice ATM switch router
NCDP	Network Clock Distribution Protocol
NE	network element
NMS	network management system
NNI	Network-Network Interface
NSAP	network service access point
NTP	Network Time Protocol

Table B-1 List of Acronyms (continued)

Acronym	Definition
NVRAM	nonvolatile random-access memory
OAM	operation, administration, and management
OC	optical carrier
OSF	oversubscription factor
OSPF	Open Shortest Path First
OVC	output virtual circuit
PAP	Password Authentication Protocol
PCR	peak cell rate
PD	packet discard
PDH	pleisiochronous digital hierarchy
PG	peer group
PGL	peer group leader
PIF	physical interface
PIM	Protocol Independent Multicast
PIR	peak information rate
PLCP	Physical Layer Convergence Protocol
PNNI	Private Network-Network Interface
PPP	Point-to-Point Protocol
PRS	primary reference source
PTSE	PNNI topology state element
PVC	permanent virtual channel
PVCL	permanent virtual channel link
PVP	permanent virtual path
PVPL	permanent virtual path link
QoS	quality of service
QSAAL	Q.2931 protocol over signalling ATM adaptation layer
RADIUS	Remote Dial-In User Service
RAIG	Resource Availability Information Groups
RCAC	Resource Call Admission Control
rcp	remote copy protocol
RCSF	Running Configuration Synchronization Facility
RDI	remote defect indication
RISC	reduced instruction set computing
RM	resource management
RMON	Remote Monitoring
RR	relative rate

Table B-1 List of Acronyms (continued)

Acronym	Definition
RS	rate scheduler
SCR	sustainable cell rate
SDH	Synchronous Digital Hierarchy
SGCP	Simple Gateway Control Protocol
SIN	ships in the night
SNAP	Subnetwork Access Protocol
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network
SRTS	synchronous residual time stamp
SSH	Secure Shell Protocol
SSRP	Simple Server Redundancy Protocol
STM	Synchronous Transfer Module
STS	Synchronous Transfer Signal
SVC	switched virtual channel
SVCC	switched virtual channel connection
SVPC	switched virtual path connection
TACACS	Terminal Access Controller Access Control System
TBR	tag bit rate
TDM	time-division multiplexer
TDP	Tag Distribution Protocol
TVC	tag virtual channel
UBR	unspecified bit rate
UBR+	unspecified bit rate plus
UDP	User Datagram Protocol
UNI	User-Network Interface
UPC	usage parameter control
UTP	unshielded twisted-pair
VBR	variable bit rate
VBR-NRT	variable bit rate non-real time
VBR-RT	variable bit rate real time
VC	virtual channel
VCC	virtual channel connection
VCI	virtual channel identifier
VCL	virtual channel link
VP	virtual path
VPCI	virtual path connection identifier

Table B-1 List of Acronyms (continued)

Acronym	Definition
VPI	virtual path identifier
VPN	virtual private network
VRF	virtual routing and forwarding
WK	well-known
WRR	weighted round-robin

Symbols

Numerics

A

B

C

D

E

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y