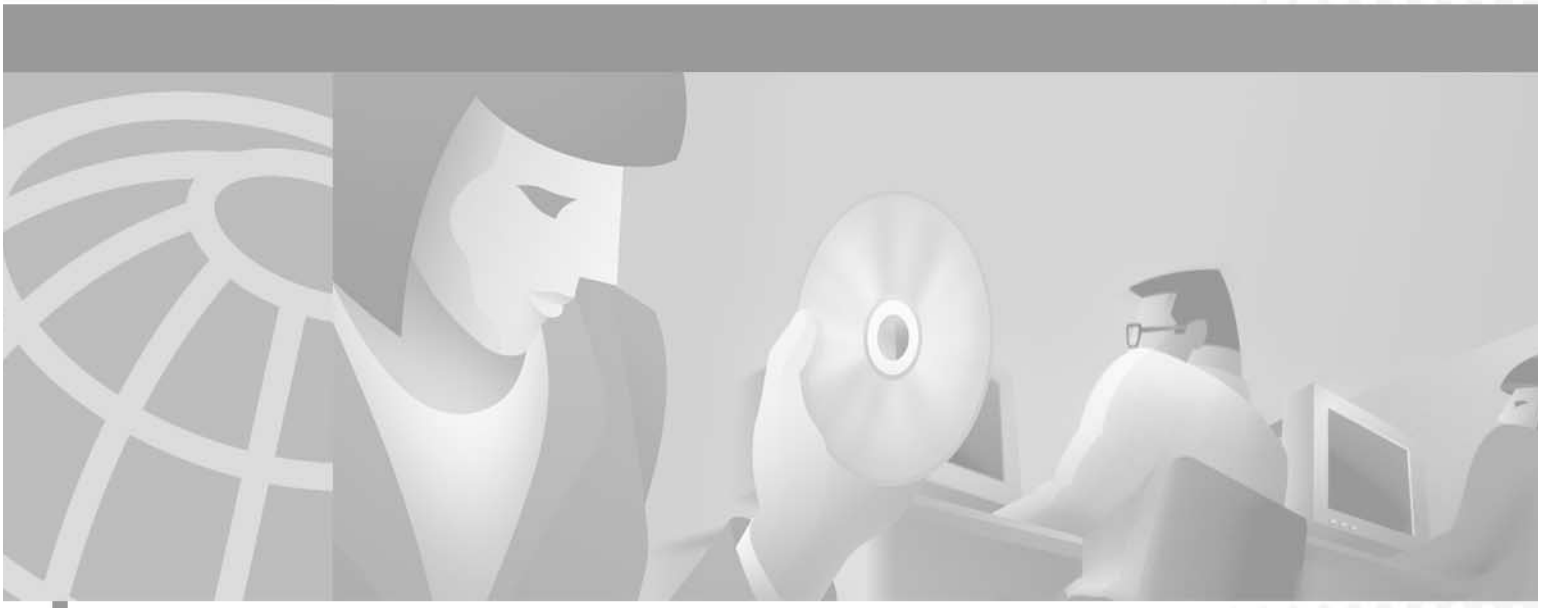

Cisco MGX Route Processor Module Installation and Configuration Guide

Release 1.1
October 2001

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Text Part Number: 78-12278-02

The following information is for FCC compliance of Class A devices: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case users will be required to correct the interference at their own expense.

The following information is for FCC compliance of Class B devices: The equipment described in this manual generates and may radiate radio-frequency energy. If it is not installed in accordance with Cisco's installation instructions, it may cause interference with radio and television reception. This equipment has been tested and found to comply with the limits for a Class B digital device in accordance with the specifications in part 15 of the FCC rules. These specifications are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation.

Modifying the equipment without Cisco's written authorization may result in the equipment no longer complying with FCC requirements for Class A or Class B digital devices. In that event, your right to use the equipment may be limited by FCC regulations, and you may be required to correct any interference to radio or television communications at your own expense.

You can determine whether your equipment is causing interference by turning it off. If the interference stops, it was probably caused by the Cisco equipment or one of its peripheral devices. If the equipment causes interference to radio or television reception, try to correct the interference by using one or more of the following measures:

• Turn the television or radio antenna until the interference stops.

• Move the equipment to one side or the other of the television or radio.

• Move the equipment farther away from the television or radio.

• Plug the equipment into an outlet that is on a different circuit from the television or radio. (That is, make certain the equipment and the television or radio are on circuits controlled by different circuit breakers or fuses.)

Modifications to this product not authorized by Cisco Systems, Inc. could void the FCC approval and negate your authority to operate the product.

Cisco MGX Route Processor Module Installation and Configuration Guide

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☐ Network management ☐ Other: _____

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6 I access this information through: ____% Cisco.com ____% CD-ROM
____% Printed docs ____% Other: _____

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Part Number: 78-12278-02 S/W Release (if applicable): 1.1

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CONTENTS

About This Guide

This section discusses the objectives, audience, organization, and conventions of the *Cisco MGX Route Processor Module Installation and Configuration Guide, Release 1.1*.

Objectives

This publication will step you through the initial site preparation and installation of the Cisco MGX Route Processor Module (RPM) for both the RPM/B and RPM-PR. Troubleshooting, maintenance procedures, and cable specifications are also provided.

Only basic software configuration information is included in this publication. For detailed software configuration information, refer to the MGX 8230, MGX 8250, MGX 8850 and Cisco IOS configuration and command reference publications. These publications are available on the Documentation CD-ROM that comes with your RPM card, or you can order printed copies.

Audience

This publication is designed for a person installing the RPM, who should be familiar with electronic circuitry and wiring practices, and has experience as an electronic or electromechanical technician.

Organization

The major sections of this publication are as follows:

Chapter	Chapter Title	Description
Chapter 1	Overview of the MGX RPM	Discusses the features and specifications of the Route Processor Module (RPM).
Chapter 2	Preparing to Install the MGX RPM	Discusses environmental requirements, safety recommendations, and describes the various ports and how to prepare for connections between networks and ports.
Chapter 3	Installing the MGX RPM	Includes basic installation information and describes how to make connections to LANs, the main processor switch control module (PXM), and console terminal.

Chapter	Chapter Title	Description
Chapter 4	Cabling the MGX RPM Back Cards	Provides an overview of the RJ45-4E/B, FE, and FDDI back card functionality, cabling and connectors and procedures for making port adapter connections.
Chapter 5	Configuring the MGX RPM	Describes the initial configuration of the RPM using Configuration Mode or AutoInstall. This chapter also explains how to configure all port adapter interfaces, followed by procedures for configuring permanent virtual circuits (PVCs) and connections with other RPMs.
Chapter 6	Setting Up Connections Between Other Devices and the RPM	Describes how to set up connections between the RPM and the PXM, service modules or BPX.
Chapter 7	Configuring MPLS and VPN	Describes MPLS and VPN features used with the RPM in MGX 8230, MGX 8250, and MGX 8850 switches.
Appendix A	Maintaining the MGX RPM	Provides selected maintenance procedures, including password recovery, virtual configuration register settings, and system code upgrades.
Appendix B	Cable and Connector Specifications	Provides pinouts for the various ports on the RPM and associated cables.
Appendix C	IOS and Configuration Basics	Provides information on the IOS operating system and configuring the RPM card.

Conventions

This publication uses the following conventions to convey instructions and information.

Command descriptions use these conventions:

- Commands and keywords are in **boldface**.
- Arguments for which you supply values are in *italics*.
- Elements in square brackets ([ ]) are optional.
- Alternative keywords are grouped in braces ({ }) and are separated by vertical bars (|).

Examples use these conventions:

- Terminal sessions and information the system displays are in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters, such as passwords, are in angle brackets (< >).
- Default responses to system prompts are in square brackets ([ ]).

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this publication.

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

Tip Provides additional information that can help you understand the product or complete a task more efficiently.

Warning Definition

Warning **Means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.**

Waarschuwing **Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen.**

Varoitus **Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista.**

Attention **Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents.**

Warnung **Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt.**

Avvertenza **Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti.**

Advarsel **Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du vare oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker.**

Aviso **Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos físicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes.**

¡Atención! **Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes.**

Varning! **Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador.**

Related Documentation

The following Cisco publications contain additional information related to the operation of this product and associated equipment in a Cisco WAN switching network.

Cisco WAN Manager Release 10.5 Documentation

The product documentation for the Cisco WAN Manager (CWM) network management system for Release 10.5 is listed in Table 1.

Table 1 Cisco WAN Manager Release 10.5 Documentation

Title	Description
Cisco WAN Manager Installation Guide for Solaris, Release 10.5 DOC-7812948=	Provides procedures for installing Release 10 of the CWM network management system and Release 5.3 of CiscoView.
Cisco WAN Manager User's Guide, Release 10.5 DOC-7812945=	Describes how to use the CWM Release 10 software which consists of user applications and tools for network management, connection management, network configuration, statistics collection, and security management.
Cisco WAN Manager SNMP Service Agent, Release 10.5 DOC-7812947=	Provides information about the CWM Simple Network Management Protocol Service Agent, an optional adjunct to CWM used for managing Cisco WAN switches using SNMP.
Cisco WAN Manager Database Interface Guide, Release 10.5 DOC-7812944=	Provides information about accessing the CWM Informix OnLine database that is used to store information about the network elements.

Table 2 WAN CiscoView Release 10 Documentation

Title	Description
WAN CiscoView Release 3 for the MGX 8850 Edge Switch, Release 1 DOC-7811242=	Provides instructions for using this network management software application that allows you to perform minor configuration and troubleshooting tasks.
WAN CiscoView Release 3 for the MGX 8250 Edge Concentrator, Release 1 DOC-7811241=	Provides instructions for using this network management software application that allows you to perform minor configuration and troubleshooting tasks.
WAN CiscoView Release 3 for the MGX 8230 Multiservice Gateway, Release 1 DOC-7810926=	Provides instructions for using this network management software application that allows you to perform minor configuration and troubleshooting tasks.

Cisco MGX 8850 Release 2.1 Documentation

The product documentation for the installation and operation of the MGX 8850 Release 2.1 switch is listed in Table 3.

Table 3 Cisco MGX 8850 Switch Release 2.1 Documentation

Title	Description
Cisco MGX 8850 Routing Switch Hardware Installation Guide, Release 2.1 DOC-7812561=	Describes how to install the MGX 8850 routing switch. It explains what the switch does, and covers site preparation, grounding, safety, card installation, and cabling.
Cisco MGX 8850 Switch Command Reference, Release 2.1 DOC-7812563=	Describes how to use the commands that are available in the CLI[1]of the MGX 8850 switches.
Cisco MGX 8850 Switch Software Configuration Guide, Release 2.1 DOC-7812551=	Describes how to configure the MGX 8850 switches to operate as ATM edge and core switches. This guide also provides some operation and maintenance procedures.
Cisco MGX 8850 SNMP Reference, Release 2.1 DOC-7812562=	Provides information on all supported MIB[2]objects, support restrictions, traps, and alarms for the AXSM, PXM45, and RPM. PNNI is also supported.
Cisco MGX and SES PNNI Network Planning Guide DOC-7813543=	Provides guidelines for planning a PNNI network that uses the MGX 8850 switches and the BPX 8600 switches. When connected to a PNNI network, each BPX 8600 series switch requires a Service Expansion Shelf (SES) for PNNI route processing.
Cisco MGX Route Processor Module Installation and Configuration Guide, Release 2.1 DOC-7812510=	Describes how to install and configure the MGX Route Processor Module (RPM-PR) in the MGX 8850 Release 2.1 switch. Also provides site preparation, troubleshooting, maintenance, cable and connector specifications, and basic IOS configuration information.

1. CLI = command line interface
2. MIB = Management Information Base

SES PNNI Release 1.1 Documentation

The product documentation that contains information for the understanding, the installation, and the operation of the Service Expansion Shelf (SES) PNNI Controller is listed in Table 4.

Table 4 SES PNNI Controller Release 1.1 Documentation

Title	Description
Cisco SES PNNI Controller Software Configuration Guide, Release 1.1 DOC-7813539=	Describes how to configure, operate, and maintain the SES PNNI Controller.
Cisco SES PNNI Controller Software Command Reference, Release 1.1 DOC-7813541=	Provides a description of the commands used to configure and operate the SES PNNI Controller.
Cisco MGX and SES PNNI Network Planning Guide DOC-7813543=	Provides guidelines for planning a PNNI network that uses the MGX 8850 switches and the BPX 8600 switches. When connected to a PNNI network, each BPX 8600 series switch requires a SES for PNNI route processing.

Cisco WAN Switching Software, Release 9.3 Documentation

The product documentation for the installation and operation of the Cisco WAN Switching Software Release 9.3 is listed in Table 5.

Table 5 Cisco WAN Switching Release 9.3 Documentation

Title	Description
Cisco BPX 8600 Series Installation and Configuration, Release 9.3.30 DOC-7812907=	Provides a general description and technical details of the BPX broadband switch.
Cisco WAN Switching Command Reference, Release 9.3.30 DOC-7812906=	Provides detailed information on the general command line interface commands.
Cisco IGX 8400 Series Installation Guide, Release 9.3.30 OL-1165-01 (online only)	Provides hardware installation and basic configuration information for IGX 8400 Series switches running Switch Software Release 9.3.30 or earlier.
Cisco IGX 8400 Series Provisioning Guide, Release 9.3.30 OL-1166-01 (online only)	Provides information for configuration and provisioning of selected services for the IGX 8400 Series switches running Switch Software Release 9.3.30 or earlier.
Cisco IGX 8400 Series Regulatory Compliance and Safety Information DOC-7813227=	Provides regulatory compliance, product warnings, and safety recommendations for the IGX 8400 Series switch.

MGX 8850 Multiservice Switch, Release 1.1.40 Documentation

The product documentation that contains information for the installation and operation of the MGX 8850 Multiservice Switch is listed in Table 6.

Table 6 MGX 8850 Multiservice Gateway Documentation

Title	Description
Cisco MGX 8850 Multiservice Switch Installation and Configuration, Release 1.1.3 DOC-7811223=	Provides installation instructions for the MGX 8850 multiservice switch.
Cisco MGX 8800 Series Switch Command Reference, Release 1.1.3. DOC-7811210=	Provides detailed information on the general command line for the MGX 8850 switch.
Cisco MGX 8800 Series Switch System Error Messages, Release 1.1.3 DOC-7811240=	Provides error message descriptions and recovery procedures.
Cisco MGX 8850 Multiservice Switch Overview, Release 1.1.3 OL-1154-01 (online only)	Provides a technical description of the system components and functionary of the MGX 8850 multiservice switch from a technical perspective.
Cisco MGX Route Processor Module Installation and Configuration Guide, Release 1.1 DOC-7812278=	Describes how to install and configure the MGX Route Processor Module (RPM/B and RPM-PR) in the MGX 8850, MGX 8250, and MGX 8230 Release 1 switch. Also provides site preparation, troubleshooting, maintenance, cable and connector specifications, and basic IOS configuration information.
1.1.40 Version Software Release Notes Cisco WAN MGX 8850, MGX 8230, and MGX 8250 Switches DOC-7813594=	Provides new feature, upgrade, and compatibility information, as well as known and resolved anomalies.

MGX 8250 Edge Concentrator, Release 1.1.40 Documentation

The documentation that contains information for the installation and operation of the MGX 8250 Edge Concentrator is listed in Table 7.

Table 7 MGX 8250 Multiservice Gateway Documentation

Title	Description
Cisco MGX 8250 Edge Concentrator Installation and Configuration, Release 1.1.3 DOC-7811217=	Provides installation instructions for the MGX 8250 Edge Concentrator.
Cisco MGX 8250 Multiservice Gateway Command Reference, Release 1.1.3 DOC-7811212=	Provides detailed information on the general command line interface commands.

Table 7 MGX 8250 Multiservice Gateway Documentation (continued)

Title	Description
Cisco MGX 8250 Multiservice Gateway Error Messages, Release 1.1.3 DOC-7811216=	Provides error message descriptions and recovery procedures.
Cisco MGX 8250 Edge Concentrator Overview, Release 1.1.3 DOC-7811576=	Describes the system components and functionality of the MGX 8250 edge concentrator from a technical perspective.
Cisco MGX Route Processor Module Installation and Configuration Guide, Release 1.1 DOC-7812278=	Describes how to install and configure the MGX Route Processor Module (RPM/B and RPM-PR) in the MGX 8850, MGX 8250, and MGX 8230 Release 1 switch. Also provides site preparation, troubleshooting, maintenance, cable and connector specifications, and basic IOS configuration information.
1.1.40 Version Software Release Notes Cisco WAN MGX 8850, MGX 8230, and MGX 8250 Switches DOC-7813594=	Provides new feature, upgrade, and compatibility information, as well as known and resolved anomalies.

MGX 8230 Multiservice Gateway, Release 1.1.40 Documentation

The documentation that contains information for the installation and operation of the MGX 8230 Edge Concentrator is listed in Table 8.

Table 8 MGX 8230 Multiservice Gateway Documentation

Title	Description
Cisco MGX 8230 Edge Concentrator Installation and Configuration, Release 1.1.3 DOC-7811215=	Provides installation instructions for the MGX 8230 Edge Concentrator.
Cisco MGX 8230 Multiservice Gateway Command Reference, Release 1.1.3 DOC-7811211=	Provides detailed information on the general command line interface commands.
Cisco MGX 8230 Multiservice Gateway Error Messages, Release 1.1.3 DOC-78112113=	Provides error message descriptions and recovery procedures.
Cisco MGX 8230 Edge Concentrator Overview, Release 1.1.3 DOC-7812899=	Provides a technical description of the system components and functionary of the MGX 8250 edge concentrator from a technical perspective.

Table 8 MGX 8230 Multiservice Gateway Documentation (continued)

Title	Description
Cisco MGX Route Processor Module Installation and Configuration Guide, Release 1.1 DOC-7812278=	Describes how to install and configure the MGX Route Processor Module (RPM/B and RPM-PR) in the MGX 8850, MGX 8250, and MGX 8230 Release 1 switch. Also provides site preparation, troubleshooting, maintenance, cable and connector specifications, and basic IOS configuration information.
1.1.40 Version Software Release Notes Cisco WAN MGX 8850, MGX 8230, and MGX 8250 Switches DOC-7813594=	Provides new feature, upgrade, and compatibility information, as well as known and resolved anomalies.

Obtaining Documentation

The following sections explain how to obtain documentation from Cisco Systems.

World Wide Web

You can access the most current Cisco documentation on the World Wide Web at the following URL:

http://www.cisco.com

Translated documentation is available at the following URL:

http://www.cisco.com/public/countries_languages.shtml

Documentation CD-ROM

Cisco documentation and additional literature are available in a Cisco Documentation CD-ROM package, which is shipped with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or through an annual subscription.

Ordering Documentation

Cisco documentation is available in the following ways:

- Registered Cisco Direct Customers can order Cisco product documentation from the Networking Products MarketPlace:

  http://www.cisco.com/cgi-bin/order/order_root.pl

- Registered Cisco.com users can order the Documentation CD-ROM through the online Subscription Store:

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

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco corporate headquarters (California, USA) at 408 526-7208 or, elsewhere in North America, by calling 800 553-NETS (6387).

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Obtaining Technical Assistance

Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools by using the Cisco Technical Assistance Center (TAC) Web Site. Cisco.com registered users have complete access to the technical support resources on the Cisco TAC Web Site.

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- Register for online skill assessment, training, and certification programs

You can self-register on Cisco.com to obtain customized information and service. To access Cisco.com, go to the following URL:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC is available to all customers who need technical assistance with a Cisco product, technology, or solution. Two types of support are available through the Cisco TAC: the Cisco TAC Web Site and the Cisco TAC Escalation Center.

Inquiries to Cisco TAC are categorized according to the urgency of the issue:

- Priority level 4 (P4)—You need information or assistance concerning Cisco product capabilities, product installation, or basic product configuration.
- Priority level 3 (P3)—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- Priority level 2 (P2)—Your production network is severely degraded, affecting significant aspects of business operations. No workaround is available.
- Priority level 1 (P1)—Your production network is down, and a critical impact to business operations will occur if service is not restored quickly. No workaround is available.

Which Cisco TAC resource you choose is based on the priority of the problem and the conditions of service contracts, when applicable.

Cisco TAC Web Site

The Cisco TAC Web Site allows you to resolve P3 and P4 issues yourself, saving both cost and time. The site provides around-the-clock access to online tools, knowledge bases, and software. To access the Cisco TAC Web Site, go to the following URL:

http://www.cisco.com/tac

All customers, partners, and resellers who have a valid Cisco services contract have complete access to the technical support resources on the Cisco TAC Web Site. The Cisco TAC Web Site requires a Cisco.com login ID and password. If you have a valid service contract but do not have a login ID or password, go to the following URL to register:

http://www.cisco.com/register/

If you cannot resolve your technical issues by using the Cisco TAC Web Site, and you are a Cisco.com registered user, you can open a case online by using the TAC Case Open tool at the following URL:

http://www.cisco.com/tac/caseopen

If you have Internet access, it is recommended that you open P3 and P4 cases through the Cisco TAC Web Site.

Cisco TAC Escalation Center

The Cisco TAC Escalation Center addresses issues that are classified as priority level 1 or priority level 2; these classifications are assigned when severe network degradation significantly impacts business operations. When you contact the TAC Escalation Center with a P1 or P2 problem, a Cisco TAC engineer will automatically open a case.

To obtain a directory of toll-free Cisco TAC telephone numbers for your country, go to the following URL:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

Before calling, please check with your network operations center to determine the level of Cisco support services to which your company is entitled; for example, SMARTnet, SMARTnet Onsite, or Network Supported Accounts (NSA). In addition, please have available your service agreement number and your product serial number.

Overview of the MGX RPM

This chapter provides an overview of the MGX Route Processor Module (RPM) and its relationship to the MGX 8230, MGX 8250, and MGX 8850 switch.

This chapter contains the following sections:

- Performance
- Physical Overview
- System Specifications
- MGX 8850 Cellbus
- ATM Deluxe Integrated Port Adapter
- RPM Midplane Connector
- Front Panel LEDs
- Cisco IOS Software Compatibility

Note Unless otherwise noted, RPM refers to both the RPM/B and RPM-PR. Also, unless otherwise noted, MGX 8850 refers to the MGX 8230, MGX 8250, and the MGX 8850 Release 1 switches and chassis.

Performance

The RPM is a high performance router module based on the Cisco 7200 router and modified to fit into a full-height MGX 8850, MGX 8250 and MGX 8230 service module slot (see Figure 1-1). The RPM is available in the following versions:

- The RPM/B is based on the Cisco 7200 NPE-150 router engine that is capable of processing up to 140 kpps (kilo-packets per second).
- The RPM-PR is a high-performance router module based on an NPE-400 processor, featuring an upgraded QED RM7000 processor subsystem that provides performance of more than 300 kpps throughput for IP packet forwarding.

The RPM provides integrated IP in an ATM platform, enabling services such as integrated Point-to-Point Protocol (PPP), Frame Relay termination, and IP virtual private networks (VPNs) using MPLS technology. It provides Cisco IOS(tm)-based multiprotocol routing over ATM, Frame Relay and ATM Interface Layer 3 Termination, Local Server Interconnect over High-Speed LANs, Access Concentration, and switching between Ethernet LANs and the WAN facilities of the MGX 8850.

The RPM includes interprocessor communication to the main processor switch control module for management, including configuration, mode supervision, (for example, redundancy/load sharing control) and software and configuration file management.

Physical Overview

The RPM module fits in a 32-slot, full-height MGX 8850 chassis and connects to the PXM and other service modules via the midplane.

The RPM receives power from the midplane and communicates over the midplane with the PXM using IPC over ATM. The RPM runs Cisco IOS software.

The RPM installs into one slot in the MGX 8850 chassis and connects to the MGX 8850 midplane (see Figure 1-1). When the RPM is installed (in the front of the MGX 8850 chassis), its back cards must also be connected to the midplane (from the rear of the MGX 8230, MGX 8250 or MGX 8850 chassis) and their ports must be cabled to network devices. (See Figure 1-2.) See Chapter 4, "Cabling the MGX RPM Back Cards" for cable and connection details.

The RPM has an integrated ATM interface—a permanently attached ATM port adaptor based on the Cisco ATM Deluxe module—and can support up to two optional back cards to provide LAN connectivity (see Figure 1-3). The two back cards can be either a four-port Ethernet or a one-port Fast Ethernet.

All RPM trunk traffic travels over its integrated ATM interface to the MGX 8850 cellbus (the ATM port is connected to the cellbus), or to the PXM uplink to the PXM, which routes it to the appropriate service module or RPM Both the RPM and the PXM are configured manually to create the appropriate connections before any user data can flow through the PXM.

Note Slots 7 and 8 are reserved for the PXM cards occupying the full height of the chassis (see Figure 1-1, which shows the PXM cards installed in the front of the MGX 8850 chassis).

In Figure 1-2, which shows the rear view of the MGX 8850 chassis, PXM-UI cards are visible in the top slots and T3 cards in the bottom slots, directly behind the PXMs. In the same illustration, RPM cards are installed in slots 9 and 10 and occupy the full height of the chassis. FE and 4E cards are installed in the bottom slots, directly behind the RPM cards.

Note FDDI cards must be installed in the top slot of the RPM/B. (RPM-PR does not support FDDI cards.)

Figure 1-1 RPM Installed in a MGX 8250 or MGX 8850 Chassis (Front View)

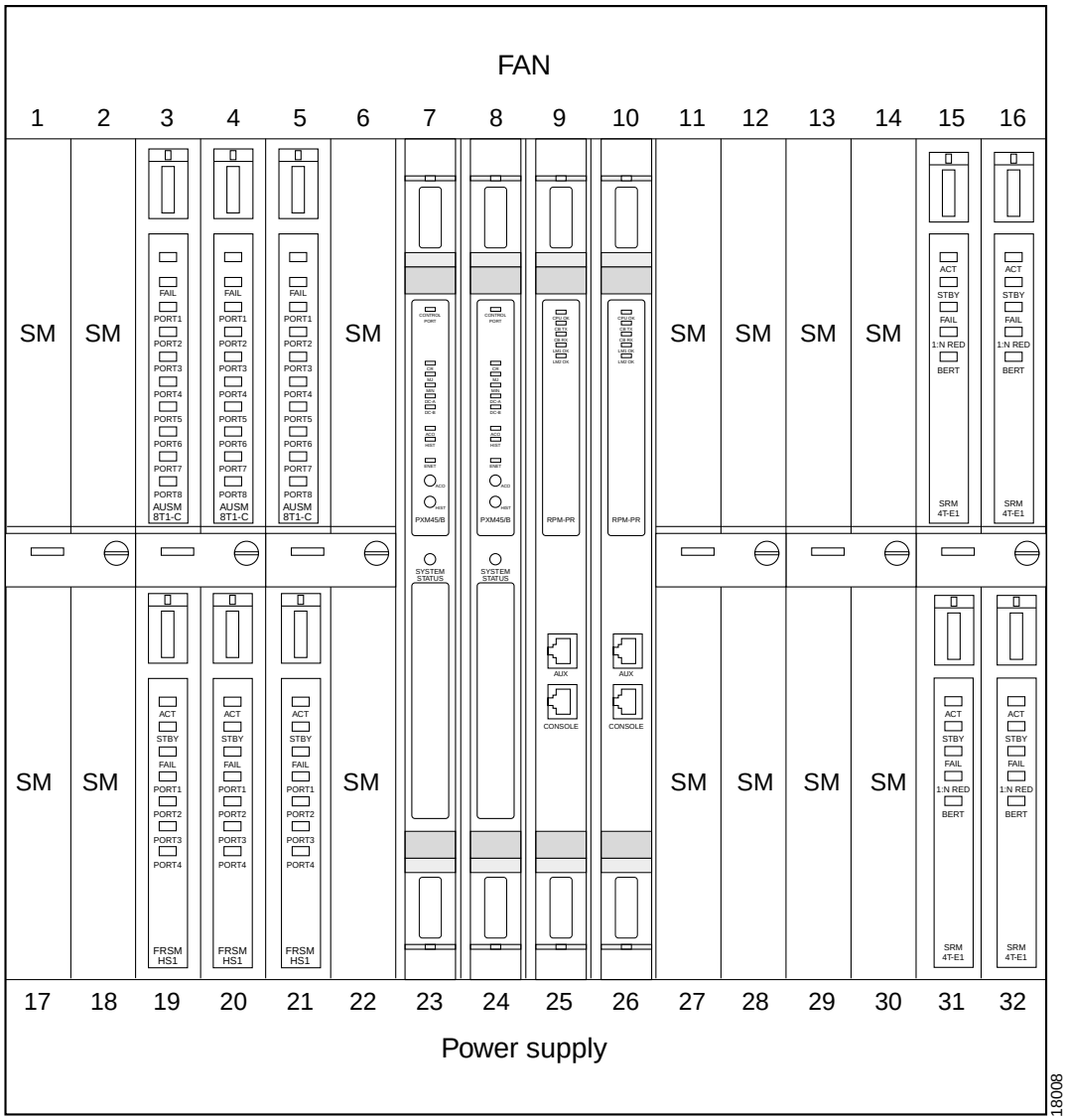
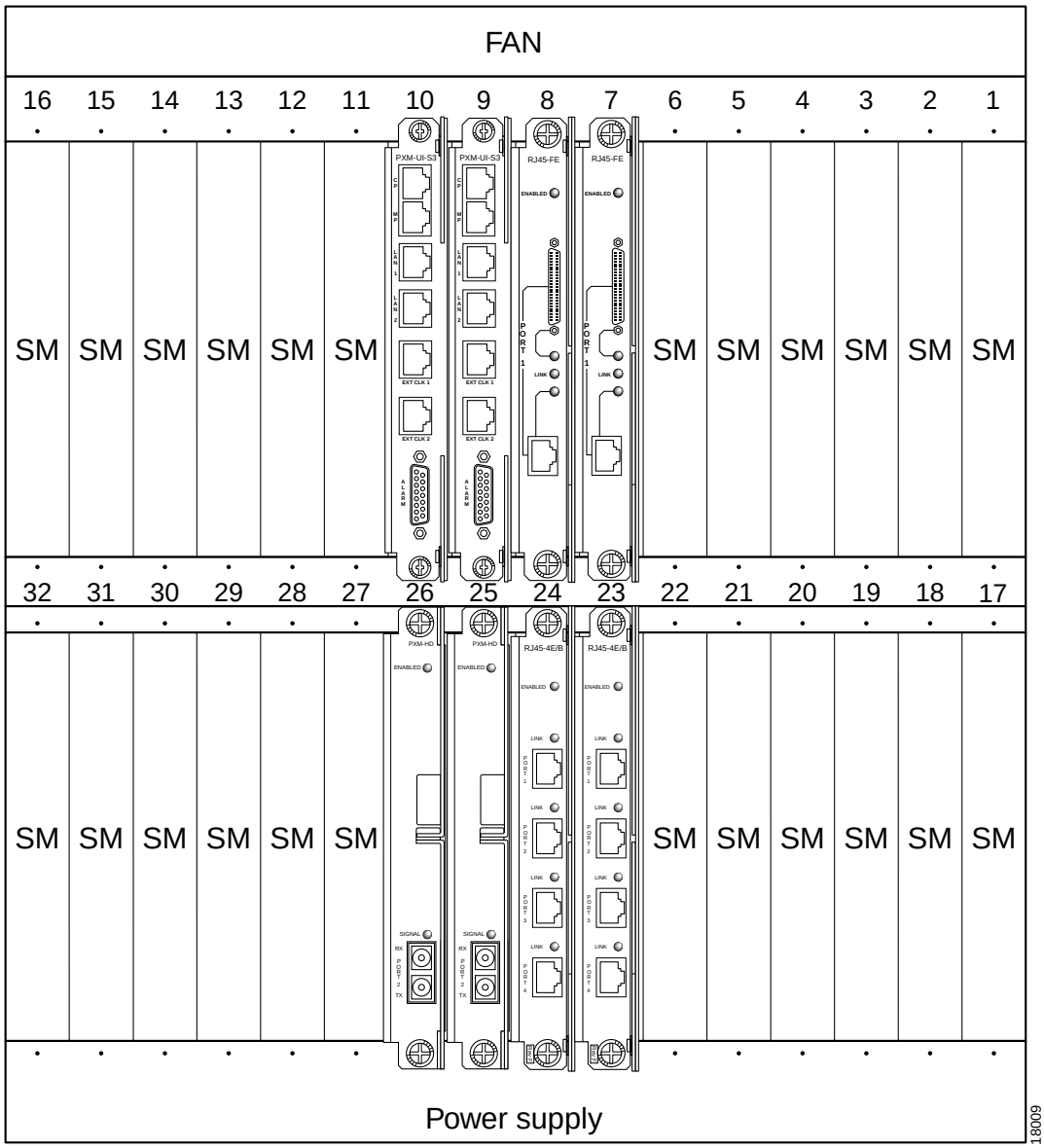


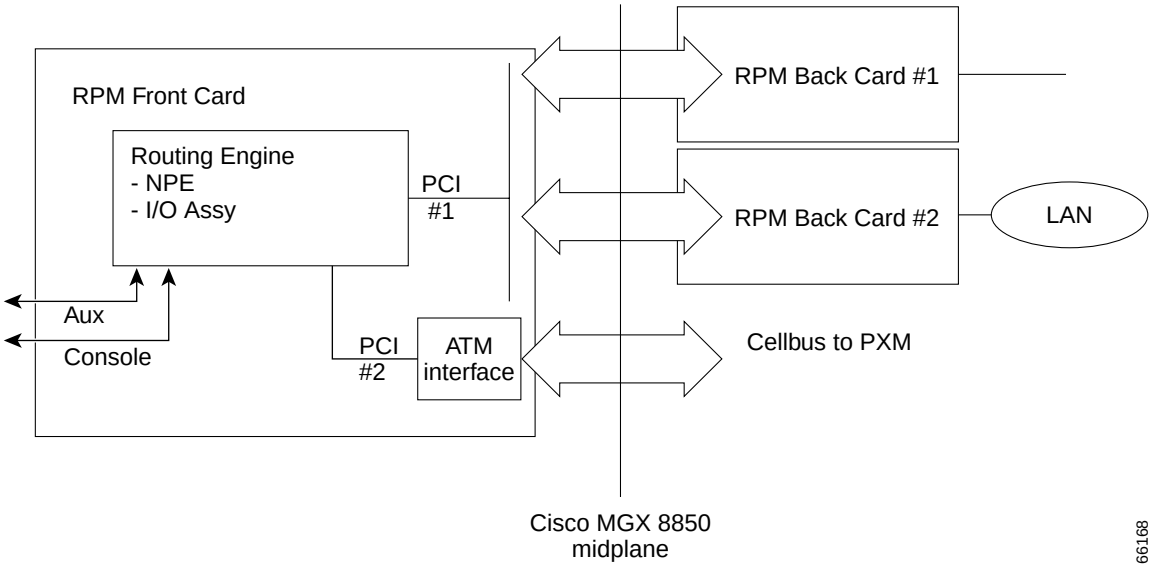
Figure 1-2 RPM Back Cards and Service Modules Installed in an MGX 8250 or MGX 8850 (Back View)



The RPM/B and RPM-PR use NPE-150 and NPE-400 router engines, respectively. They also use an integrated ATM interface and a cellbus ASIC to interface with the MGX 8850 cellbus controllers.

The MGX 8850 shelf can be completely populated with 12 RPM blades, which allows you to use multiple RPMs to achieve load sharing. Load sharing is achieved by manually distributing connections across multiple embedded RPM router blades.

Figure 1-3 RPM Connected to the MGX 8230, MGX 8250 or MGX 8850 Midplane and Back Cards



The RPM fits into the MGX 8850 midplane architecture so that the front card provides Cisco IOS router services, and the back cards provide physical network connectivity. The RPM front card also provides ATM connectivity to MGX 8230, MGX 8250 or MGX 8850 cellbuses at full-duplex OC-6.

The RPM back cards are connected to the front card by a dual PCI bus (refer to Figure 1-3). Each RPM card can be equipped with two single-height back cards. Initially, two single-height back card types are supported. They are

- 4-port Ethernet
- 1-port Fast Ethernet

Although in most service provider network cores, the recommended routing protocols are OSPF or IS-IS, with additional use of BGP, where appropriate, the RPM supports all of the following IP routing protocols:

- static route
- IGRP
- RIPv1
- RIPv2
- OSPF
- EIGRP
- IS-IS
- BGP with multiprotocol extensions

Note MAC addresses remain with the chassis slot, not with a particular card or interface. Any new RPM card placed in a slot will receive the MAC address previously assigned to that slot. Moving an RPM card to a different slot or chassis results in its receiving a new MAC address.

System Specifications

Table 1-1 summarizes the key attributes of the RPM cards.

Table 1-1 RPM Card Specifications

Front card	RPM/B	RPM-PR.
Card dimensions	15.65" x 15.83" (double-height).	15.65" x 15.83" (double-height).
Weight (front and back card)	4.80 lb	6.75 lb
Processor	150 MHz R4700A RISC	350 MHz R7000A RISC.
IP router throughput	~140,000 packets per second	~350,000 packets per second
Power consumption	150 W	55 W
Cellbus interface speed	Up to OC-6	Up to OC-6
Memory	Up to 128 Mbytes DRAM, 20 Mbytes Flash	Up to 512 Mbytes DRAM, 32 Mbytes Flash
Console port	Configuration port; asynch interface speed configurable up to 9600 baud.	Configuration port; asynch interface speed configurable up to 9600 baud.
Auxiliary port	Maintenance port; asynch interface speed based on config-register up to 38,400 baud.	Maintenance port; asynch interface speed based on config-register up to 38,400 baud.
Back cards	MGX-RJ45-4E/B, 4-port Ethernet (10BaseT). 1-port FDDI (full duplex, half duplex, SMF, MMF) Two Fast Ethernet back cards: • MGX-MMF-FE • MGX-RJ45-FE	MGX-RJ45-4E/B, 4-port Ethernet (10BaseT). Two Fast Ethernet back cards: • MGX-MMF-FE • MGX-RJ45-FE

MGX 8850 Cellbus

The MGX 8850 cellbus in the MGX 8850 midplane communicates between the RPM, service modules (cellbus slaves), and the PXM (cellbus master) (see Figure 1-3). Each cellbus is connected to a set of PXM cards. Only one cellbus may be active at a time.

Communication from master to slaves consists of a broadcast to all slaves. The first byte of the cell header contains addressing information. Each slave will monitor data traffic and “pick up” cells that are destined to its slot. Also, a multicast bit allows all slaves to receive a cell simultaneously.

Communication from the slaves to the master is complicated, because many slaves may attempt to transmit simultaneously, requiring arbitration among slaves. At the start of a given cell period, the master will poll all slaves to see if they have anything to send. By the end of the current cell, the master will grant or allow one of the slaves to transmit. Polling and data transmission occur simultaneously.

ATM Deluxe Integrated Port Adapter

The ATM deluxe port adapter provides a single ATM interface to the MGX 8850 cellbus interface (CBI). The ATM port adapter is a permanent, internal ATM interface. As such, it has no cabling to install and does not support interface types. It connects internally, directly to the MGX 8850 midplane.

The CBI is derived from several modules. There are two distinct blocks, one is the ATM SAR function and the other is the cellbus controller ASIC. The ATM SAR function is based on the ATM Deluxe Dual SAR design and is implemented with two LSI ATMizerIIs. For the RPM, the design is implemented with two ATMizerII+. The cellbus controller is based on the Cisco WAN cellbus ASIC.

The following features from the ATM Deluxe port adapter are supported on the MGX 8850 switch:

- ATM layer
  - Support for all 24 bits of the UNI VP/VC field, any arbitrary address
  - Respond to OAM flows (F4/F5)
  - AAL5 for data traffic
- Traffic management
  - Full ABR and VBR-nrt support (TM 4.0), all modes
  - Per VC rates from 2.3 kbps to 155 Mbps, in 2.3 kbps increments

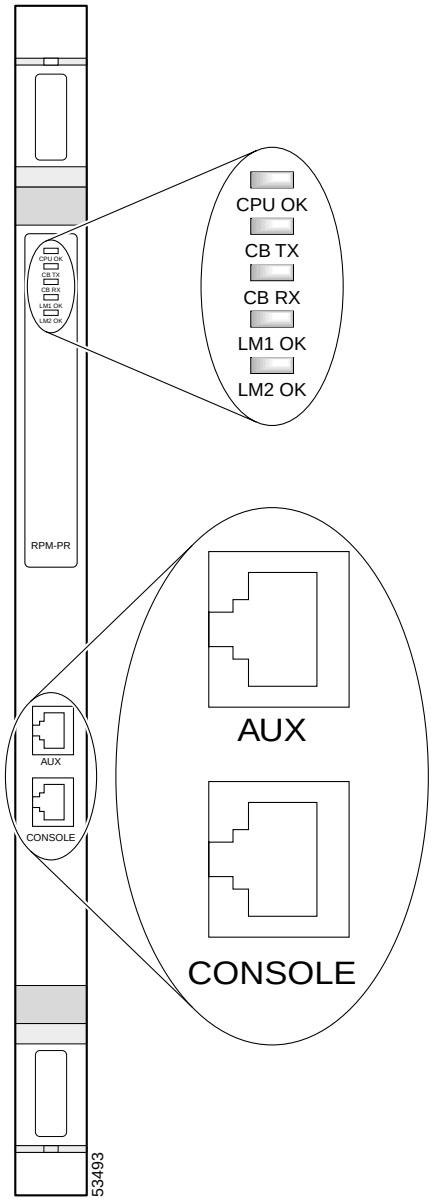
RPM Midplane Connector

The MGX 8850 cellbus and the RPM back cards connect through two sets of connectors placed at the rear of the RPM motherboard (see Figure 1-3). Each connector has 360 pins, for a total of 720 pins.

Front Panel LEDs

The LEDs indicate the current operating condition of the RPM (see Figure 1-4). You can observe the LEDs and note the fault condition the RPM is encountering. If you need assistance, contact your system administrator or TAC, if necessary. For a table showing how to interpret RPM front panel LED activity, see Appendix A, “Maintaining the MGX RPM,” the “Reading Front Panel LEDs” section.

Figure 1-4 Front Panel of the RPM-PR



Cisco IOS Software Compatibility

This RPM release is supported in Cisco IOS Release 12.2(4)T.

For more information about RPM software configuration, refer to the Cisco IOS Configuration and Command Reference publications.

Preparing to Install the MGX RPM

This chapter describes the tasks you must perform before you begin to install the MGX Route Processor Module (RPM). This chapter includes the following sections:

- Safety Recommendations
- Maintaining Safety with Electricity
- General Site Requirements
- Installation Checklist
- Creating a Site Log
- Preparing to Connect to a Network

Safety Recommendations

Note The RPM is a service module that fits in the MGX 8850, MGX 8250 and MGX 8230 chassis. Refer to the *Cisco MGX 8850 Multiservice Switch Installation and Configuration*, *Cisco MGX 8250 Edge Concentrator Installation and Configuration*, and *Cisco MGX 8230 Edge Concentrator Installation and Configuration* guides, respectively, for further recommendations about safety.

The guidelines that follow help ensure your safety and protect the MGX 8850 equipment. The list of guidelines may not address all potentially hazardous situations in your working environment, so be alert, and exercise good judgement at all times.

The safety guidelines are as follows:

- Keep the chassis area clear and dust-free before, during, and after installation.
- Keep tools away from walk areas where people could fall over them.
- Do not wear loose clothing or jewelry, such as rings, bracelets, or chains, which may become caught in the chassis.
- Wear safety glasses if you are working under any conditions that may be hazardous to your eyes.
- Do not perform any actions that create a potential hazard to people or make the equipment unsafe.
- Never attempt to lift an object that is too heavy for one person to handle.

Maintaining Safety with Electricity

Warning **Before working on a chassis or working near power supplies, unplug the power cords on an AC-powered system. On a DC-powered system, disconnect the power at the circuit breakers.**

Follow these guidelines when working on equipment powered by electricity:

- Locate the emergency power-off switch for the room in which you are working. If an electrical accident occurs, you can quickly turn off the power.
- Do not work alone if potentially hazardous conditions exist anywhere in your workspace.
- Never assume that power is disconnected from a circuit: always check the circuit.
- Carefully look for possible hazards in your work area, such as moist floors, ungrounded power extension cords, or missing safety grounds.
- If an electrical accident occurs:
  - Use caution—Do not let yourself become a victim.
  - Disconnect power from the system.
  - If possible, send another person to get medical aid. Otherwise, assess the condition of the victim then call for help.
- Use the MGX 8850 AC and MGX 8850 DC systems within their marked electrical ratings and product usage instructions.
- Install the MGX 8850 or MGX 8850 DC systems with the following local, national, or international electrical codes:
  - United States—National Fire Protection Association (NFPA70), United States National Electrical Code.
  - Canada—Canadian Electrical Code, Part 1, CSA C22.1.
  - Other countries—International Electromechanical Commission (IEC) 364, Part 1 through Part 7.
- MGX 8850 AC models are shipped with a 3-wire electrical cord with a grounding-type plug that fits only a grounding type power outlet. This is a safety feature that you should not circumvent. Equipment grounding should comply with local and national electrical codes.
- MGX 8850 DC models are equipped with DC power entry modules and require you to terminate the DC input wiring on a DC source capable of supplying at least 60 amps. A 60-amp circuit breaker is required at the 48 VDC facility power source. An easily accessible disconnect device should be incorporated into the facility wiring. Be sure to connect the grounding wire conduit to a solid earth ground. A closed loop ring is recommended to terminate the ground conductor at the ground stud.
- Other DC power guidelines are as follows:
  - Only a DC power source that complies with the safety extra low voltage (SELV) requirements of UL 1950, CSA C22.2 No. 950-95, EN 60950 and IEC 950 can be connected to an MGX 8850 DC-input power entry module.
  - MGX 8850 DC which is equipped with DC power entry modules is intended only for installation in a restricted access location. In the United States, a restricted access area is in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code ANSI/NFPA 70.

Preventing Electrostatic Discharge Damage

Electrostatic discharge (ESD) can damage equipment and impair electrical circuitry. It occurs when electronic components are improperly handled and can result in complete or intermittent failures.

Always follow ESD-prevention procedures when removing and replacing components. Ensure that the chassis is electrically connected to earth ground. Wear an ESD-preventive wrist strap, ensuring that it makes good skin contact. Connect the clip to an unpainted surface of the chassis frame to safely channel unwanted ESD voltages to ground. To properly guard against ESD damage and shocks, the wrist strap and cord must operate effectively. If no wrist strap is available, ground yourself by touching the metal part of the chassis.

Caution For safety, periodically check the resistance value of the antistatic strap, which should be between 1 to 10 mega ohms (Mohms).

General Site Requirements

This section describes the requirements your site must meet for safe installation and operation of your system. Ensure that your site is properly prepared before beginning installation.

Power Supply Considerations

Check the power at your site to ensure that you are receiving “clean” power (free of spikes and noise). Install a power conditioner if necessary.

Warning **The device is designed to work with TN power systems.**

The AC power supply of the RPM is part of the MGX 8850 chassis. The RPM, when installed in the MGX 8850 chassis, receives –48 volts DC power from the midplane.

The DC power supply of the RPM is part of the MGX 8850 chassis. The RPM, when installed in the MGX 8850 chassis, receives –48 volts VDC power from the midplane.

The RPM is installed in the MGX 8850, MGX 8250 or MGX 8230 chassis. Refer to the *Cisco MGX 8850 Multiservice Switch Installation and Configuration* guide, *Cisco MGX 8250 Edge Concentrator Installation and Configuration* guide, and *Cisco MGX 8230 Edge Concentrator Installation and Configuration* guide, respectively. The location of the MGX 8850 chassis and the layout of your equipment rack or wiring room are extremely important for proper system operation. Equipment placed too close together, inadequate ventilation, and inaccessible panels can cause system malfunctions and shutdowns, and can make RPM maintenance difficult.

Installation Checklist

The Installation Checklist lists the procedures for initial hardware installation of a new RPM. Make a copy of this checklist and mark the entries as you complete each procedure. Include a copy of the checklist for each system in your Site Log (see the next section, "Creating a Site Log").

RPM installation checklist for site _____

Installation Checklist	Verified by	Date
Installation checklist copied		
Background information placed in the Site Log		
Site power voltages verified		
Required tools available		
Additional equipment available		
Cisco MGX 8850 RPM received		
Cisco Documentation CD received		
Cisco Information Packet received		
Cisco MGX Route Processor Module Installation and Configuration Guide received		
Optional printed documentation received		
Chassis components verified		
Initial electrical connections established		
ASCII terminal or PC attached to console port		
Signal distance limits verified		
Startup sequence steps completed		
Initial system operation verified		
Software image verified		

Creating a Site Log

The Site Log provides a record of all actions relevant to the RPM. Keep it near the chassis where anyone who installs or maintains the RPM has access to it. Use the Installation Checklist (see the previous section, "Installation Checklist") to verify the steps in the installation and maintenance of your RPM. Site Log entries might include the following:

- Installation progress—Make a copy of the Installation Checklist and insert it into the Site Log. Make entries on the checklist as you complete each procedure.
- Upgrade and maintenance procedures—Use the Site Log as a record of ongoing system maintenance and expansion. Each time a procedure is performed on the RPM, update the Site Log to reflect the following procedures:
  - Configuration changes
  - Changes and updates to Cisco IOS software
  - Maintenance schedules and requirements
  - Corrective maintenance procedures performed

- Intermittent problems
- Related comments and notes

Preparing to Connect to a Network

When setting up your RPM in the MGX 8850, consider distance limitations and potential electromagnetic interference (EMI) as defined by the EIA.

Note The Ethernet, console, and auxiliary ports contain safety extra-low voltage (SELV) circuits. Connect them only to SELV-circuit equipment.

Ethernet Connection

The IEEE has established Ethernet as a standard 802.3. The RPM Ethernet implementation is as follows:

- 10BaseT—Ethernet on unshielded twisted-pair (UTP) cable. The maximum segment distance is 328 feet (100 meters). UTP cables look like the wiring used for ordinary telephones; however, UTP cables meet certain electrical standards that telephone cables do not.
- The Ethernet interface on your RPM operates at 10 Mbps.
- The connection to the 10BaseT port can be made using an Ethernet 10BaseT cable with RJ-45 connector.

The cables required to connect the RPM Ethernet and Fast Ethernet service module to an Ethernet network are not included. For cable ordering information, contact customer service.

For detailed information about making Ethernet connections, see Chapter 4, “Cabling the MGX RPM Back Cards.” For cable and port pinouts, see Appendix B, “Cable and Connector Specifications.”

Fast Ethernet Connection

The FE-TX or FE-FX port adapters on the RPM provide a 100-Mbps, 100Base-T Fast Ethernet interface and support both full-duplex and half-duplex operation.

Each Fast Ethernet port on the FE-TX port adapter has an RJ-45 connector to attach to Category 5 unshielded twisted-pair (UTP) for 100Base-TX, and a MII connector that permits connection through external transceivers to multimode fiber for 100Base-FX physical media.

Each Fast Ethernet port on the FE-FX port adapter has an SC-type fiber-optic connector for 100Base-FX, and an MII connector that permits connection through external transceivers to multimode fiber for 100Base-FX physical media.

The IEEE has established Fast Ethernet as standard 802.3u. The RPM fast ethernet implementation is as follows:

- 100Base-TX—100Base-T, half and full duplex over Category 5 unshielded twisted-pair (UTP), Electronics Industry Association/Telecommunications Industry Association [EIA/TIA]–568-compliant cable.
- 100Base-FX—100Base-T, half and full duplex over optical fiber.

For detailed information about making Fast Ethernet connections, see Chapter 4, “Cabling the MGX RPM Back Cards.” For cable and port pinouts, see Appendix B, “Cable and Connector Specifications.”

FDDI Connection (RPM/B)

FDDI, which specifies a 100-Mbps, wire-speed, token-passing dual-ring network using fiber-optic transmission media, is defined by the ANSI X3.1 standard and by ISO 9314. A typical FDDI configuration has both dual-attached and single-attached connections. The FDDI port adapters have an optical bypass switch feature by way of a DIN connection.

The FDDI port adapters provide a half-duplex FDDI for both single-mode and multimode fiber-optic cable. The two physical ports (PHY A and PHY B) are available with either single-mode (SC) or multimode MIC receptacles. Each port adapter's FDDI connection allows a maximum bandwidth of 100 Mbps per the FDDI standard.

FDDI uses two types of fiber-optic cable:

- Single-mode (also called monomode) optical fiber with SC-type, duplex and simplex connectors
- Multimode optical fiber with MIC connectors

The following FDDI port adapter combinations are available:

- PA-F-MM—FDDI PHY-A multimode, PHY-B multimode port adapter with optical bypass switch capability
- PA-F-SM—FDDI PHY-A single-mode, PHY-B single-mode port adapter with optical bypass switch capability

For detailed information about making FDDI connections, see Chapter 4, "Cabling the MGX RPM Back Cards." For cable and port pinouts, see Appendix B, "Cable and Connector Specifications."

Console and Auxiliary Ports

The RPM includes asynchronous serial console and auxiliary ports. The console and auxiliary ports provide access to the RPM either locally (with a console terminal), or remotely (with a modem). This section discusses important cabling information to consider before connecting a console terminal (an ASCII terminal or PC running terminal emulation software) to the console port or a modem to the auxiliary port.

The main difference between the console and auxiliary ports is that the auxiliary port supports hardware flow control and the console port does not. Flow control paces the transmission of data, ensuring that the receiving device can absorb the data sent to it before the sending device sends more. When the buffers on the receiving device are full, a message is sent to the sending device to suspend transmission until the data in the buffers has been processed. Because the auxiliary port supports flow control, it is ideal for use with the high-speed transmissions of a modem. Console terminals transmit more slowly than modems, so the console port is ideal for use with console terminals.

Console Port Connection

The RPM includes an EIA/TIA-232 asynchronous serial console port (RJ-45). Depending on the cable and the adapter used, this port will appear as either a DTE or DCE device at the end of the cable.

To connect an ASCII terminal to the console port, use the RJ-45 rollover cable with the female RJ-45-to-DB-25 adapter (labeled "Terminal"). To connect a PC running terminal emulation software to the console port, use the RJ-45 rollover cable with the female RJ-45-to-DB-9 adapter (labeled "Terminal"). The default parameters for the console port are 9600 baud, 8 data bits, no parity, and 2 stop bits.

The console port does not support hardware flow control. For detailed information about installing a console terminal and modem, see Chapter 3, “Installing the MGX RPM,” the “Connecting a Modem to the Auxiliary Port” and Connecting a Console Terminal or PC to the RPM Console Port” sections. For cable and port pinouts, see Appendix B, “Cable and Connector Specifications.”

Auxiliary Port Connections

The RPM includes an EIA/TIA-232 asynchronous serial auxiliary port (RJ-45) that supports flow control. Depending on the cable and the adapter used, this port will appear as either a DTE or DCE device at the end of the cable. To connect a modem to the auxiliary port, use the RJ-45 rollover cable with the male RJ-45-to-DB-25 adapter (labeled Modem).

For detailed information about connecting devices to the auxiliary port, see Chapter 3, “Installing the MGX RPM,” the “Connecting a Modem to the Auxiliary Port” section. For cable and port pinouts, see Appendix B, “Cable and Connector Specifications.”

Installing the MGX RPM

This chapter describes how to install the Cisco MGX Route Processor Module, and includes the following sections:

- Inspecting the System
- Required Tools and Parts
- Installing and Removing the RPM Cards
- Installing and Removing Back Cards in the MGX 8850 Midplane
- Connecting a Console Terminal or PC to the RPM Console Port
- Connecting a Modem to the Auxiliary Port
- Upgrading from an RPM/B Card to an RPM-PR Card

Inspecting the System

Do not unpack the RPM until you are ready to install it. If the final installation site is not ready, keep the card in its shipping container to prevent accidental damage. When you have determined where you want the RPM installed, proceed with unpacking it.

The RPM and any optional equipment you ordered might be shipped in more than one container. When you unpack each shipping container, check the packing list to ensure that you received all of the following items:

- Cisco MGX 8850 RPM.

Note Cisco Systems does not provide 10BaseT, 100BaseT and optical fiber cables required to connect the back cards to external devices. These cables must be ordered from commercial cable vendors. For pinouts to these cables, see Appendix B, "Cable and Connector Specifications."

Cisco Systems also does not provide console and auxiliary cables in the RPM kit. Console and auxiliary cables can be ordered as spares from Cisco Systems.

- *Cisco Information Packet* publication.
- Cisco Documentation CD-ROM.
- Optional printed publications, as specified on your order.

Inspect all items for shipping damage. If anything appears to be damaged, or if you encounter problems when installing or configuring your system, contact the Cisco Technical Assistance Center (TAC).

Required Tools and Parts

Installing the RPM requires tools and parts that are not provided as standard equipment. The following tools and equipment are required to install the RPM in the MGX 8850 chassis:

- Number 2 Phillips head screw driver.
- ESD-preventive wrist strap.
- Cables for 4E or 4E/B, FE and FDDI port adapter interfaces.

Note RPM-PR does not support the 4E or FDDI back card. The new version of the 4E is called 4E/B. Other than a new label on the card, changes to the card are transparent to the user. Thus, the cables for the 4E back card work with the 4E/B.

- Console and auxiliary cables
  - Standard RJ-45-to-RJ-45 rollover cable (for more information, see Appendix B, "Cable and Connector Specifications," the "Identifying a Rollover Cable" section.)
  - Cable adapters

    RJ-45-to-DB-9 female DTE adapter (labeled "Terminal")

    RJ-45-to-DB-25 female DTE adapter (labeled "Terminal")

    RJ-45-to-DB-25 male DCE adapter (labeled "Modem")

Note For cable information, see Chapter 2, "Preparing to Install the MGX RPM," the "Preparing to Connect to a Network" section. For cable pinouts, see Appendix B, "Cable and Connector Specifications."

- Console terminal (an ASCII terminal or a PC running terminal emulation software) configured for 9600 baud, 8 data bits, no parity, and 2 stop bits.

  See the "Connecting a Console Terminal or PC to the RPM Console Port" section later in this chapter for the procedure to connect a console terminal.
- Modem for remote access (optional).

Installing and Removing the RPM Cards

The following sections describe how to install and remove the RPM in the MGX 8850 midplane.

Note Installing and removing RPM service modules is similar to installing and removing other service modules, such as FRSM, AUSM, VISM, SRM, which also go into the midplane from the front of the MGX 8850 chassis. However, those service modules are half-height and have only one insertion/extraction lever on their faceplates.

Warning **Only trained and qualified personnel should install or replace this equipment.**

Warning **To prevent damage to the cards from static electricity, put on a wrist strap and connect it to any convenient metal contact on the system or card cage before you touch any cards.**

Note It is not necessary to power OFF the MGX 8850 chassis. The RPM can be removed and inserted in the MGX 8850 chassis while the system is up and running.

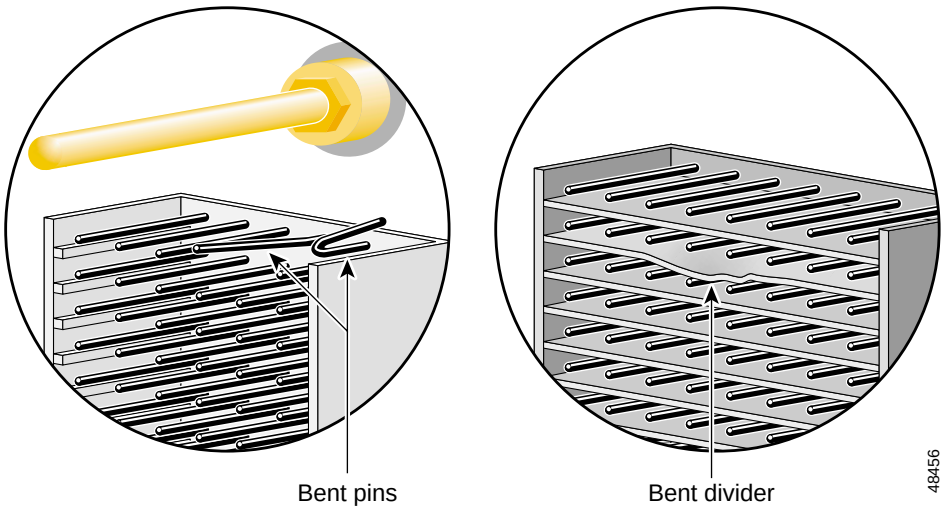
Before Installing Front or Back Cards

Before you install a front or back card, perform the following inspections.

- Inspect the backplane for bent pins or bent dividers between pin rows (see Figure 3-1).

  If the backplane has bent pins, do not install a card in that slot. Installing a card into a damaged backplane slot will damage the connector on the card.

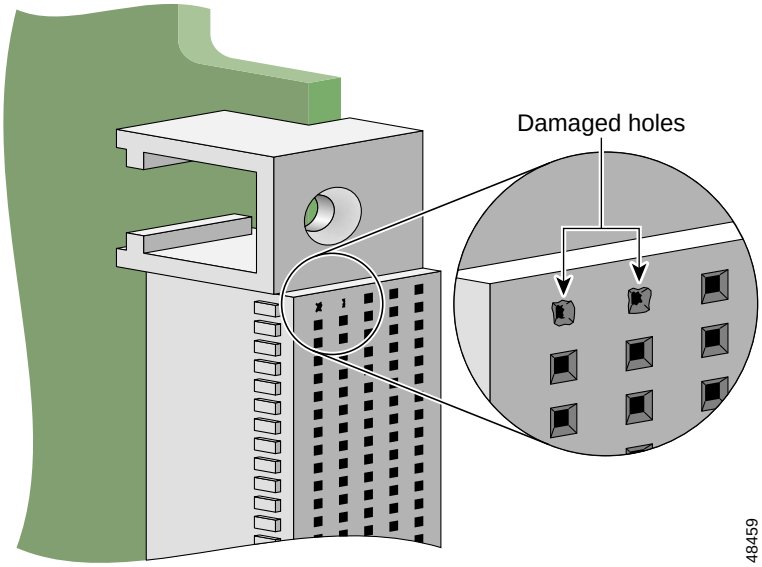
Figure 3-1 Backplane Inspection Check Points



- Inspect the card for damaged holes on the connector (see Figure 3-2).

  If the connector has damaged holes, do not install the card. Installing a card that has a damaged connector will damage the backplane. Return damaged cards to Cisco.

Figure 3-2 Damaged Connectors on the Card



Installing the RPM Front Card

Perform the following steps to install the RPM in the MGX 8850 chassis.

Step 1 Position the rear edge of the card over the appropriate slot card guide at the top and bottom of the cage.

Note Verify that the intended slot for the card is the correct slot before you install the card.

Step 2 Carefully slide the RPM card all the way into the slot.

Step 3 Press both extractor levers until they snap into the vertical position.

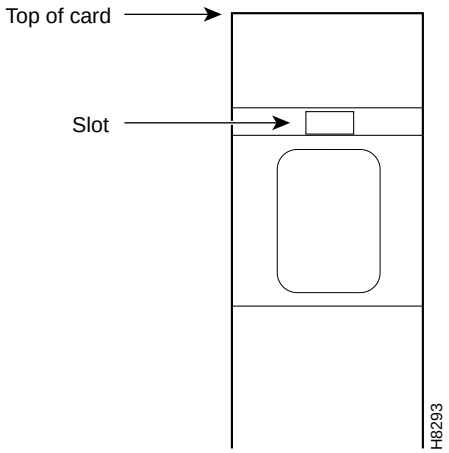
Note The RPM should slide in and out with only slight friction on the adjacent board EMI gaskets. Do not use force. Investigate any binding.

Removing the RPM Card

Double-height front cards have a latch on the ejector at both the top and the bottom of the front panel.

Warning **To prevent damage to the cards from static electricity, put on a wrist strap and connect it to any convenient metal contact on the system or card cage before you touch any cards.**

Figure 3-3 Front Card Extractor Latch



Perform the following steps to remove an RPM front card from the MGX 8850 chassis.

Step 1 Detach all cables from the card.

Step 2 Press the tip of a small, flat-head screwdriver into the slot of the extractor lever (see Figure 3-3); press until the latch springs open, to approximately 10°.

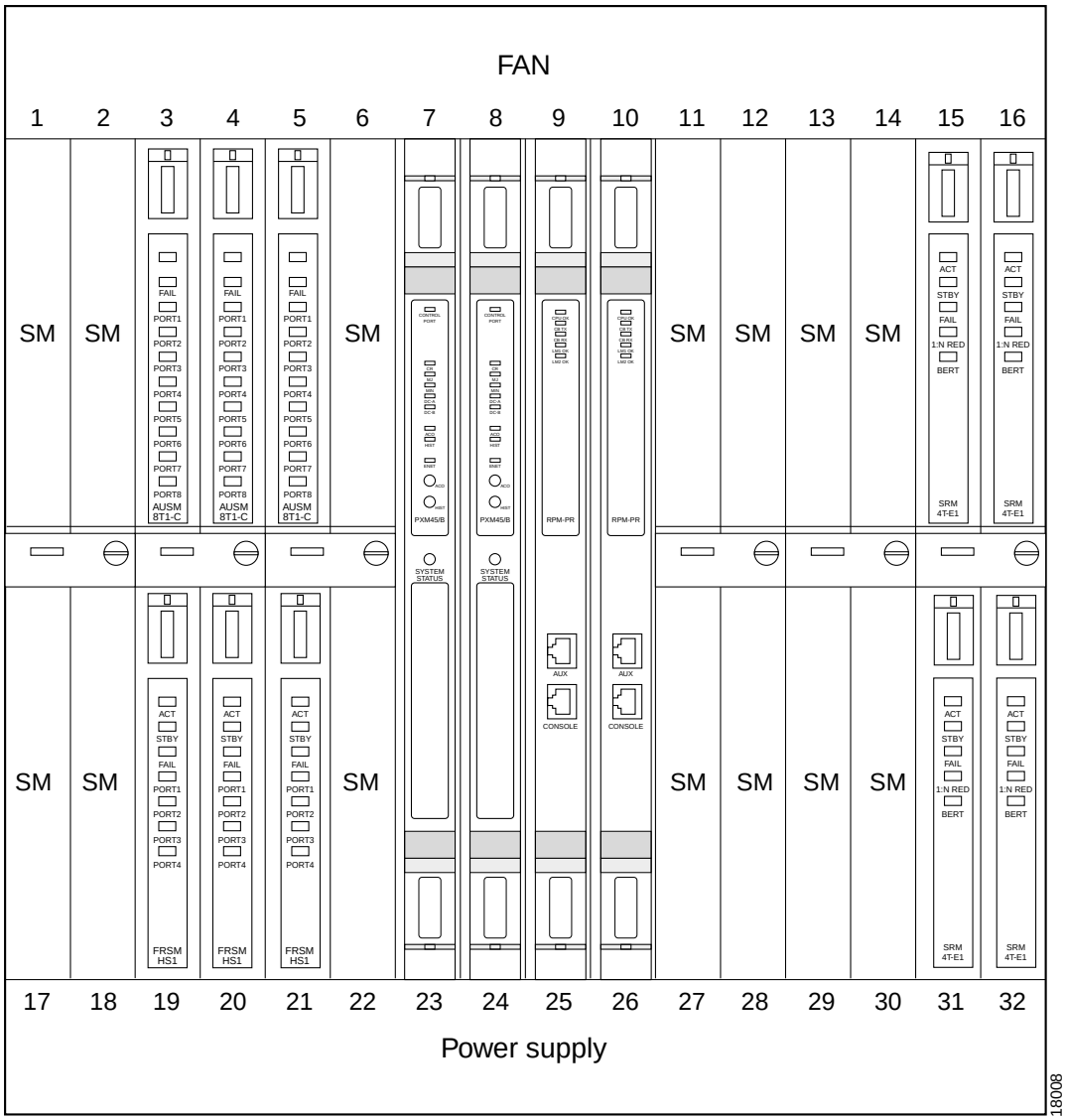
Step 3 To separate the card from the backplane connector, pull the extractor lever(s) out.

Step 4 Gently pull the RPM out along the guides. If it sticks, jiggle it gently.

Step 5 Carefully pull the card out of the card cage. Store it in an anti-static bag.

Note The RPM slides along plastic guides into the front of the MGX 8850 system (see Figure 3-4) and connects to the chassis midplane. When removing the RPM, you may feel some resistance as the midplane connector unseats.

Figure 3-4 RPM Installed in the MGX 8850 Chassis (Front View)



Installing and Removing Back Cards in the MGX 8850 Midplane

The following sections describe how to install and remove the Ethernet, Fast Ethernet or FDDI (RPM/B only) back cards from the MGX 8850 midplane.

Installing the Back Cards

Use the following procedure to install the Ethernet, Fast Ethernet or FDDI (RPM/B only) back cards in the MGX 8850 midplane.

Note Ensure that the two extractor levers are in the "in" position. When the card is being inserted into the slot, the levers should be vertical along the line of the back card.

Step 1 Position the rear card guides over the appropriate slot (directly behind the RPM in the chassis) at the top and bottom of the card cage.

There are two connectors each with 360 pins, for a total of 720 pins. The top and bottom connectors are mechanically identical.

Step 2 Push the back card firmly but gently into the slot and then all the way into the connectors on the midplane.

Note Correct alignment between connector pins and receptacles is *extremely* important. First, make sure all pins on the card are straight. Make sure the connector on the card is aligned with the midplane connector. Insert the card gently. It may be necessary to push the card slightly to one side to achieve alignment.

Step 3 Tighten the two captive screws on the back card faceplate.

Tighten the upper and lower screws to prevent misalignment of the card. Do not overtighten the screws. Tighten only enough to secure the card.

Back cards installed in an MGX 8850 chassis and connected to the midplane are illustrated in Figure 3-5.

Note Slots 7 and 8 are reserved for the PXM-45 cards occupying the full height of the chassis. You can see PXM-45-UI-S3 cards in the top slots and T3 cards in the bottom slots in Figure 3-5. The illustration shows RPMs in slots 9 and 10 occupying the full height of the chassis. You can see FE and 4E or 4E/B cards in the bottom slots.

FDDI back cards must be installed in the top slot of the RPM/B.

Removing the RPM Back Cards

Use the following procedure to remove the Ethernet or the Fast Ethernet back cards from the MGX 8850 midplane.

Step 1 Label and detach any cables connected to the back card.

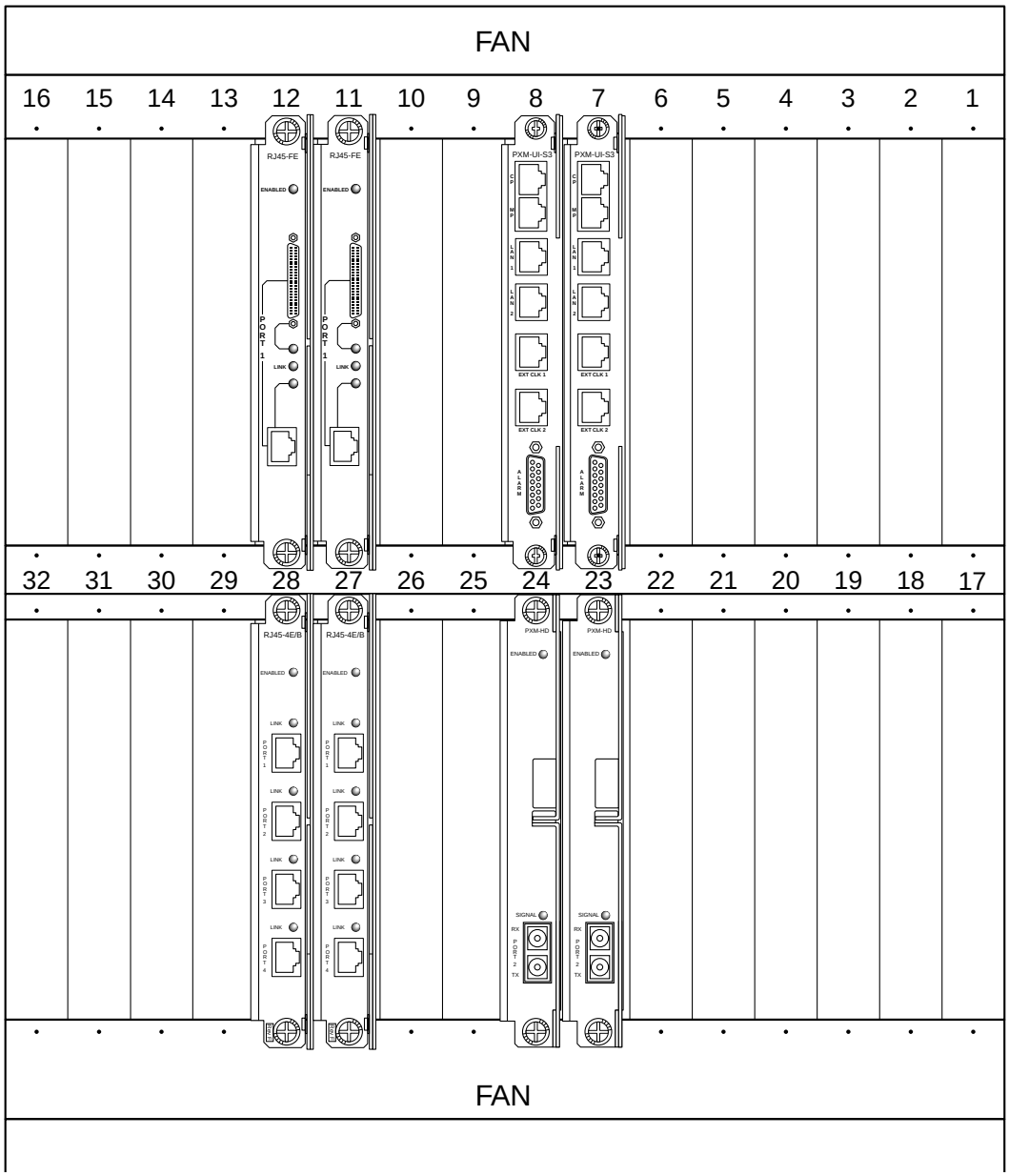
Step 2 Use a flat screwdriver to remove the two retaining screws in the back card faceplate.

Step 3 Pull both extractor levers out to the horizontal position.

This action will start the removal of the card.

Step 4 Gently pull the card out of the card cage.

Figure 3-5 RPM Back Cards Connected to a MGX 8850 (Back View)



Connecting a Console Terminal or PC to the RPM Console Port

The RPM includes asynchronous serial console and auxiliary ports. These ports provide administrative access to the RPM either locally using a console terminal, or remotely using a modem.

Use the following procedure to connect a terminal (an ASCII terminal or a PC running terminal emulation software) to the console port on the RPM.

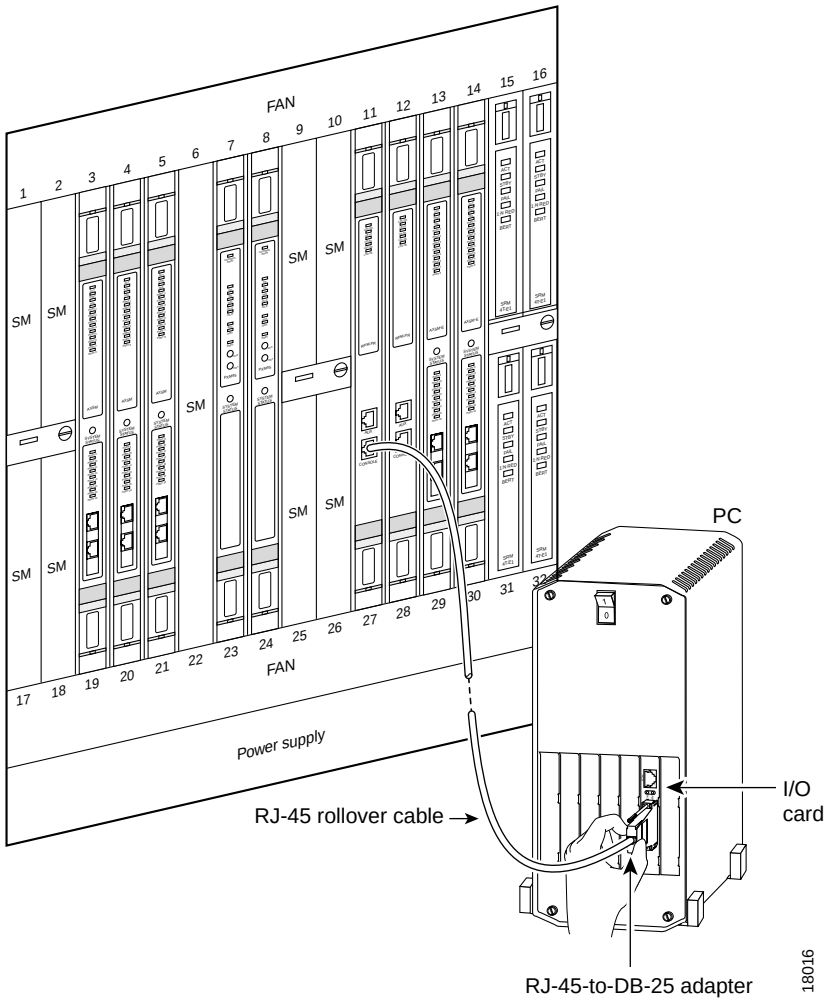
Step 1 Connect the terminal (see Figure 3-6) using the thin, flat, RJ-45-to-RJ-45 rollover cable (which looks like a telephone cable) and an RJ-45-to-DB-9 or RJ-45-to-DB-25 adapter (labeled "Terminal").

For cable pinouts, see Appendix B, "Cable and Connector Specifications."

Step 2 Configure your terminal or PC terminal emulation software for 9600 baud, 8 data bits, no parity, and 2 stop bits.

Note The default parameters for the internal console port on the RPM are 9600 baud, 8 data bits, no parity and 2 stop bits.

Figure 3-6 Connecting a Console Terminal to the RPM Console Port



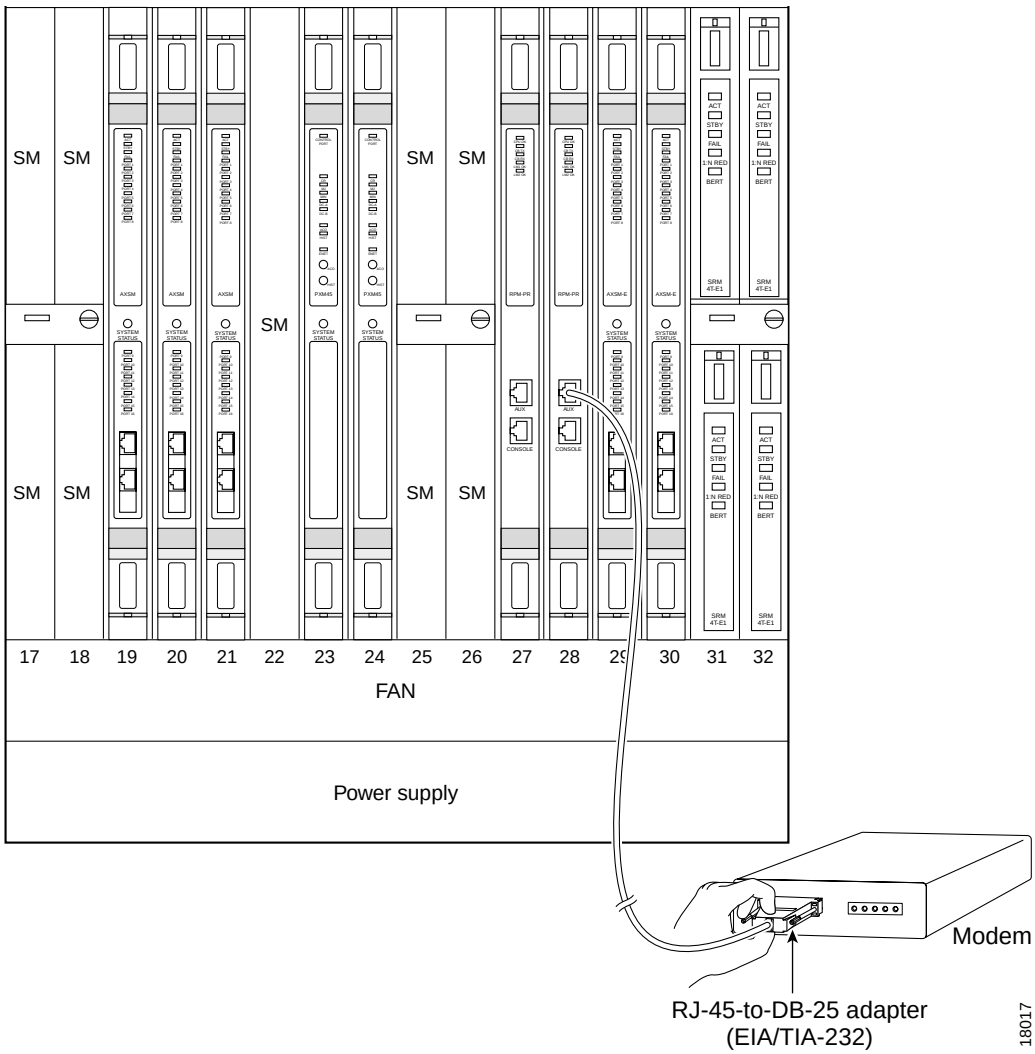
Connecting a Modem to the Auxiliary Port

Use the following procedure to connect a modem to the auxiliary port on the RPM for remote access.

Step 1 Connect a modem (see Figure 3-7) to the auxiliary port (labelled “Aux”) using the thin, flat, RJ-45-to-RJ-45 rollover cable, which looks like a telephone cable, with the RJ-45-to-DB-25 adapter (labeled “Modem”).

Step 2 Make sure that the modem and the auxiliary port on the RPM are configured for the same transmission speed (38,400 baud is maximum) and hardware flow control.

Figure 3-7 Connecting a Modem to the Auxiliary Port on the RPM



When the RPM is installed in the MGX 8850, make sure the system is powered on. Proceed to Chapter 4, “Cabling the MGX RPM Back Cards.”

Upgrading from an RPM/B Card to an RPM-PR Card

To replace an RPM/B card with an RPM-PR card, the PXM must be running MGX Software Release 1.1.34 or later, and the RPM must be running IOS release 12.2(4)T or later. Then perform the following procedure.

Step 1 Insert the RPM-PR in a test node.

Step 2 Copy the new RPM-PR boot image to the flash. Verify that the boot image is the first file in the flash.

Step 3 Modify the configuration of the file to use the latest IOS image on the c: drive by entering the **boot system c:**<*IOS_filename*> command.

Step 4 Enter the **write memory** command to save the configuration file in NVRAM.

Step 5 Enter the **show bootvar** command to check the **BOOT** variable and to verify that the card us configured to boot from the latest image.

Now the RPM-PR card is ready to replace an RPM/B card.

Step 6 Verify the following before inserting the RPM-PR in the node:

- PXM must be running a minimum firmware release of 1.1.34.
- PXM disk contains the latest IOS image specified for the RPM-PR.

Caution Once an RPM/B card is replaced with a RPM-PR card, the RPM/B card can not be re-installed. If an attempt is made to re-install the RPM/B, the module will be put into 'Mismatch'.

Caution After installing the RPM-PR card, be sure not to mix card redundancy.

Cabling the MGX RPM Back Cards

This chapter provides an overview of the RJ45-4E and FE back card functionality, cabling, and connectors as well as procedures for making back card connections. It contains the following sections:

- MGX-RJ45-4E and MGX-RJ45-4E/B Back Cards
- Attaching MGX-RJ45-4E and MGX-RJ45-4E/B Back Card Interface Cables
- Fast Ethernet Back Card
- FE-TX and FE-FX Back Cards
- Attaching FE Back Card Interface Cables
- FDDI Back Cards for the RPM/B
- Attaching FDDI Back Card Interface Cables

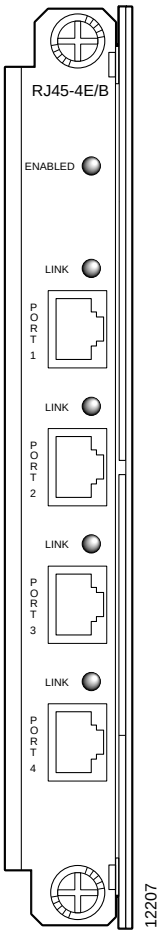
Note The RPM card within the MGX 8850 chassis supports online insertion and removal of MGX-RJ45-4E, MGX-RJ45-4E/B, and FE back cards. The ATM port adapter is internal to the RPM.

Note RPM/B supports the MGX-RJ45-4E back card and the RPM-PR supports the MGX-RJ45-4E/B back card, a new version of the RJ45-4E. Other than a new label on the card, changes to the card are transparent to the user. Thus, the cabling and features described for the RJ45-4E back card apply for the RJ45-4E/B and vice versa, unless otherwise noted.

MGX-RJ45-4E and MGX-RJ45-4E/B Back Cards

The MGX-RJ45-4E (PA-4E) and MGX-RJ45-4E/B back cards provide up to four IEEE 802.3 Ethernet 10BaseT interfaces (see Figure 4-1).

Figure 4-1 MGX-RJ45-4E/B Ethernet Back Card



Ethernet 10BaseT Overview

Ethernet is commonly used for all carrier sense multiple access/collision detection (CSMA/CD) local-area networks (LANs), which generally conform to Ethernet specifications, including IEEE 802.3 Ethernet Version 1 and IEEE 802.3 Ethernet Version 2. The slight differences between Ethernet and IEEE 802.3 are implemented in the hardware, and both are supported automatically by the Ethernet 10BaseT back card without any hardware configuration changes. Together, Ethernet and IEEE 802.3 are the most widely used LAN protocols. They are well suited to applications where a local communication medium must carry sporadic and occasionally heavy traffic.

Nodes on a CSMA/CD LAN can access the network at any time. Before sending data, the station *listens* to the network to determine if it is in use. If it is, the station waits until the network is not in use, then transmits. A collision occurs when two stations listen for network traffic, hear none, and transmit simultaneously. When this happens, both transmissions are damaged, and the stations must retransmit. The stations detect the collision and use backoff algorithms to determine when they should retransmit.

Both Ethernet and IEEE 802.3 are broadcast networks, which means that all stations hear all transmissions. Each station must examine received frames to determine whether it is the intended destination and, if it is, pass the frame to a higher protocol layer for processing.

Each IEEE 802.3 physical layer protocol has a name that summarizes its characteristics in the format *speed/signaling method/segment length*, where *speed* is the LAN speed in Mbps, *signaling method* is either *base*band or *broad*band, and *segment length* is the maximum length between stations in hundreds of meters.

IEEE 802.3 10BaseT Specifications

Table 4-1 summarizes the characteristics of IEEE 802.3 Ethernet and Ethernet Version 2 for 10BaseT.

Table 4-1 IEEE 802.3 and 10BaseT Ethernet Version 2 Physical Characteristics

Parameter	IEEE 802.3 Ethernet	10BaseT Ethernet
Data rate (Mbps)	10	10
Signaling method	Baseband	Baseband
Max. segment length (m)	500	100 (UTP)
Media	50-ohm coax (thick)	Unshielded twisted-pair (UTP)
Topology	Bus	Star

Table 4-2 lists the cabling specifications for 10-Mbps transmission over UTP and STP cables.

Table 4-2 Cabling Specifications for 10-Mbps Over UTP and STP Cables

Parameter	RJ-45
Cable specification	Category 3 or Category 5 UTP[1], 22 to 24 AWG[2]
Maximum segment length	328 ft (100 m) for 10BaseT
Maximum network length	9,186 ft (2,800 m) (with 4 repeaters)

1. Cisco Systems does not supply Category 3 and Category 5 UTP RJ-45 cables; these cables are available commercially.
2. AWG = American Wire Gauge. This gauge is specified by the EIA/TIA-568 standard.

Note The IEEE 802.3 Ethernet specifications call the RJ45-4E or RJ45-4E/B device an “end station.” The RJ45-4E and RJ45-4E/B have a built-in transceiver and connect directly to a hub or repeater.

MGX-RJ45-4E and MGX-RJ45-4E/B Back Card LEDs

The RJ45-4E and RJ45-4E/B back card contain the enabled LED, standard on all back cards, and one status LED for each port, called the “link” LED. After system initialization, the enabled LED goes on to indicate that the RJ45-4E back card has been enabled for operation. When a 10BaseT port is active, its link LED is on when a port on the RJ45-4E back card is receiving a carrier signal from the network. (See Figure 4-1.) The following conditions must be met before the enabled LED goes on:

- RJ45-4E back card is correctly connected and receiving power

- RJ45-4E-equipped card or chassis contains a valid microcode version that has been downloaded successfully
- Bus recognizes the RJ45-4E back card

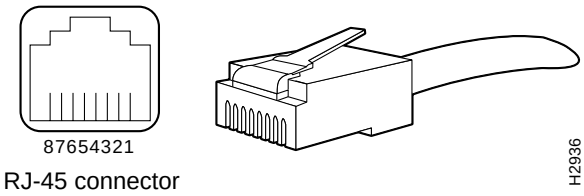
If any of these conditions is not met, or if the initialization fails for other reasons, the enabled LED does not go on.

MGX-RJ45-4E and MGX-RJ45-4E/B Back Card Receptacles and Cables

The interface connectors on the RJ45-4E back card are four individual RJ-45 receptacles. You can use all four simultaneously. Each connection supports IEEE 802.3 and Ethernet 10BaseT interfaces compliant with appropriate standards. The RJ-45 connections require external transceivers. Cisco Systems does not supply Category 5 UTP RJ-45 cables; these cables are available commercially.

Figure 4-2 shows the RJ-45 connectors. See Appendix B, “Cable and Connector Specifications” for pinouts and signals for the RJ-45 connectors.

Figure 4-2 4E RJ-45 Connections, Plug and Receptacle



Warning **The ports labeled “Ethernet,” “10BaseT,” “Console,” and “AUX” are safety extra-low voltage (SELV) circuits. SELV circuits should only be connected to other SELV circuits. Because the BRI circuits are treated like telephone-network voltage, avoid connecting the SELV circuit to the telephone network voltage (TNV) circuits.**

Attaching MGX-RJ45-4E and MGX-RJ45-4E/B Back Card Interface Cables

On a single MGX-RJ45-4E or e MGX-RJ45-4E/B back card, you can attach up to four RJ-45 connections.

Note RJ-45 cables are not available from Cisco Systems; they are available from outside commercial cable vendors.

To connect RJ-45 cables to the MGX-RJ45-4E or MGX-RJ45-4E/B back card, you can

- Attach the Category 5 UTP cable (also called straight-through 10BaseT cable) directly to the RJ-45 port on the MGX-RJ45-4E or MGX-RJ45-4E/B back card to a hub or repeater.
- Attach the network end of your RJ-45 cable to your 10BaseT hub or repeater, DTE, or other external 10BaseT equipment by using one of the following cables:

- Straight-through 10BaseT cable to connect the 10BaseT port to a 10BaseT hub (see Figure 4-3).
- Crossover 10BaseT cable to connect the 10BaseT port to a PC network interface card (see Figure 4-4).

This completes the RJ45-4E back card cable installation.

Figure 4-3 Ethernet Connection to a 10BaseT Hub

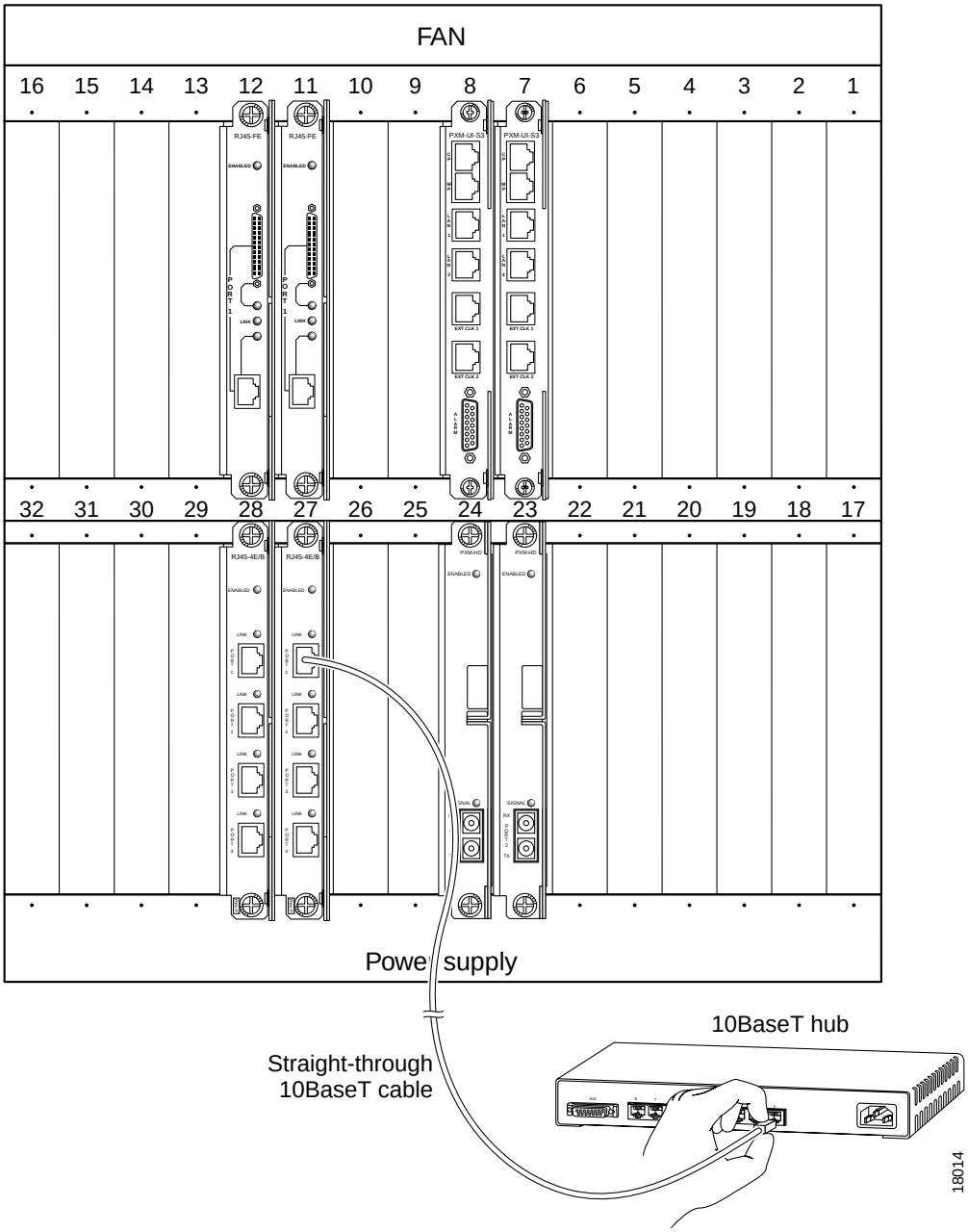
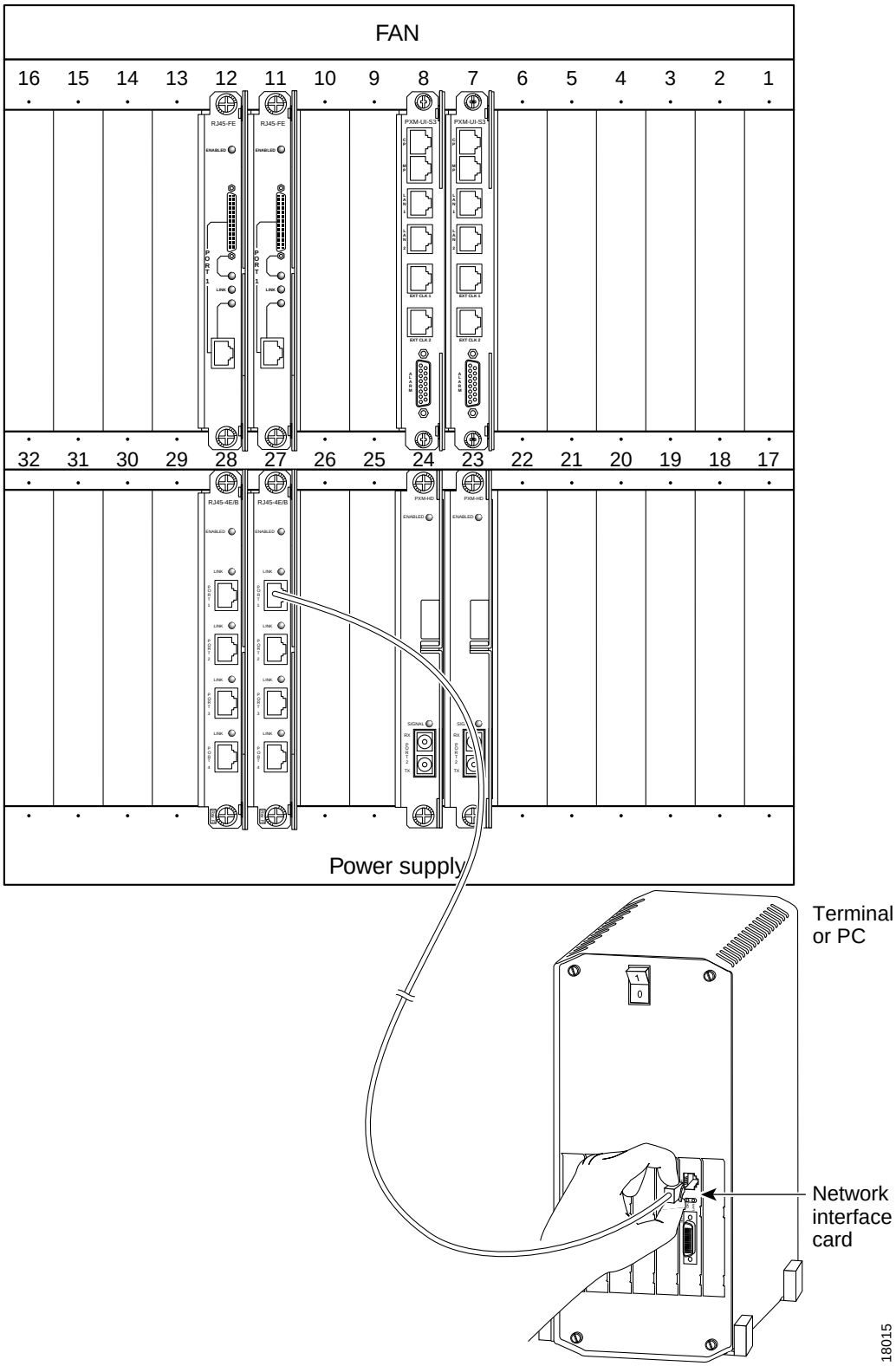


Figure 4-4 Ethernet Connection to a PC Network Interface Card



Fast Ethernet Back Card

Fast Ethernet is commonly used for all carrier sense multiple access/collision detection (CSMA/CD), local-area networks (LANs) that generally conform to Ethernet specifications, including Fast Ethernet under IEEE 802.3u.

IEEE 802.3u is well suited to applications where a local communication medium must carry sporadic, occasionally heavy traffic at high peak data rates. Stations on a CSMA/CD LAN can access the network at any time. Before sending data, the station *listens* to the network to see if it is already in use. If it is, the station waits until the network is not in use, then transmits; this is a half-duplex operation. A collision occurs when two stations listen for network traffic, hear none, and transmit very close to simultaneously. When this happens, both transmissions are damaged, and the stations must retransmit. The stations detect the collision and use backoff algorithms to determine when they should retransmit.

Both Ethernet and IEEE 802.3u are broadcast networks, which means that all stations see all transmissions. Each station must examine received frames to determine whether it is the intended destination and, if it is, pass the frame to a higher protocol layer for processing.

IEEE 802.3u specifies the following physical layers for 100BaseT:

- 100BaseTX—100BaseT, half and full duplex over Category 5 unshielded twisted-pair (UTP), Electronics Industry Association/Telecommunications Industry Association [EIA/TIA]–568-compliant cable.
- 100BaseFX—100BaseT, half and full duplex over optical fiber.

Each physical layer protocol has a name that summarizes its characteristics in the format speed/signaling method/segment length, where speed is the LAN speed in megabits per second (Mbps), signaling method is the signaling method used (either baseband or broadband), and segment length is typically the maximum length between stations in hundreds of meters. Therefore, 100BaseT specifies a 100-Mbps, baseband LAN with maximum network segments.

IEEE 802.3u 100BaseT Specifications

Table 4-3 lists the cabling specifications for 100-Mbps Fast Ethernet transmission over UTP, STP, and fiber-optic cables. Table 4-4 summarizes IEEE 802.3u 100BaseT physical characteristics.

Table 4-3 Specifications and Connection Limits for 100-Mbps Transmission

Parameter	RJ-45	MII	Parameter
Cable specification	Category 5[1] UTP[2], 22 to 24 AWG	Category 3, 4, or 5, 150-ohm UTP or STP, or multimode optical fiber	Cable specification
Maximum cable length	—	1.64 ft (0.5 m) (MII-to-MII cable[3])	Maximum cable length
Maximum segment length	328 ft (100 m) for 100BaseTX	3.28 ft (1 m)[4] or 1,312 ft (400 m) for 100BaseFX	Maximum segment length
Maximum network length	656 ft (200 m)[4] (with 1 repeater)	—	Maximum network length

1. EIA/TIA-568 or EIA-TIA-568 TSB-36 compliant.
2. Cisco Systems does not supply Category 5 UTP RJ-45 or 150-ohm STP MII cables. Both are available commercially.
3. This cable is between the MII port on the FE back card and the appropriate transceiver.
4. This length is specifically between any two stations on a repeated segment.

Table 4-4 IEEE 802.3u Physical Characteristics

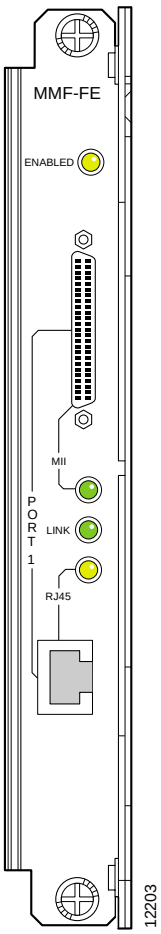
Parameter	100BaseFX	100BaseTX
Data rate (Mbps)	100	100
Signaling method	Baseband	Baseband
Maximum segment length (meters)	100 m between repeaters	100 m between DTE[1] and repeaters
Media	SC-type—dual simplex or single duplex for Rx and Tx	RJ-45MII
Topology	Star/Hub	Star/Hub

1. DTE = data terminal equipment.

FE-TX and FE-FX Back Cards

Figure 4-5 shows the FE back card.

Figure 4-5 Fast Ethernet Back Card



FE-TX Back Card

Each Fast Ethernet port on the FE-TX back card has an RJ-45 connector to attach to Category 5 unshielded twisted-pair (UTP) for 100BaseTX, and a MII connector that permits connection through external transceivers to multimode fiber for 100BaseFX physical media.

FE-FX Back Card

Each Fast Ethernet port on the FE-FX back card has an SC-type fiber-optic connector for 100BaseFX, and an MII connector that permits connection through external transceivers to multimode fiber for 100BaseFX physical media.

Fast Ethernet Back Card LEDs

The FE-TX and FE-FX back cards contain the enabled LED, which is standard on all back cards, and a bank of three status LEDs for the ports. After system initialization, the enabled LED goes on to indicate that the FE back card has been enabled for operation. The LEDs are shown in Figure 4-1.

The following conditions must be met before the enabled LED goes on:

- FE back card is correctly connected and receiving power.
- FE-equipped card or chassis contains a valid microcode version that has been downloaded successfully.
- Bus recognizes the FE back card.

If any of these conditions is not met, or if the initialization fails for other reasons, the enabled LED does not go on.

The three status LEDs indicate which port is active.

- MII—On when the MII port is selected as the active port by the controller.
- Link—When the RJ-45 or SC port is active, this LED is on when the back card is receiving a carrier signal from the network. When the MII port is active, this LED is an indication of network activity, and it flickers on and off proportionally to this activity.
- RJ-45 (or FIBER on FE-FX)—On when the RJ-45 (or FIBER) port is selected as the active port by the controller.

Note Either the MII LED *or* the RJ-45 (or FIBER) LED should be on, but never both.

Fast Ethernet Back Card Receptacles and Cables

The two interface receptacles on the FE back card are:

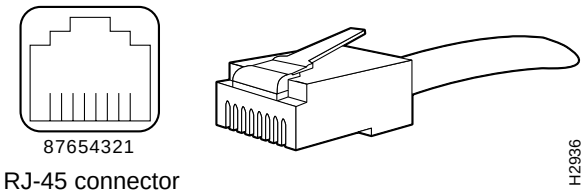
- Single MII, 40-pin, D-shell type
- Single RJ-45 (or SC-type for FE-FX optical-fiber connections)

You can use either one or the other. Only one receptacle can be used at one time. Each connection supports IEEE 802.3u interfaces compliant with the 100BaseX and 100BaseT standards. The RJ-45 connection does not require an external transceiver. The MII connection requires an external physical sublayer (PHY) and an external transceiver.

Cisco Systems does not supply Category 5 UTP RJ-45 cables; these cables are available commercially. See Appendix B, "Cable and Connector Specifications" for pinouts and signals for the FE-TX RJ-45 connectors.

Figure 4-6 shows the RJ-45 connector used for FE-TX connections.

Figure 4-6 FE-TX RJ-45 Connections (Plug and Receptacle Shown)



Warning **The ports labeled "Ethernet," "10BaseT," "Console," and "AUX" are safety extra-low voltage (SELV) circuits. SELV circuits should only be connected to other SELV circuits. Because the BRI circuits are treated like telephone-network voltage, avoid connecting the SELV circuit to the telephone network voltage (TNV) circuits.**

Figure 4-7 shows the duplex SC connector (one required for both transmit and receive). Figure 4-8 shows the simplex SC connector (two required, one for each transmit and receive) used for the FE-FX optical-fiber connections. These multimode optical-fiber cables are commercially available, but are not available from Cisco Systems.

Figure 4-7 FE-FX Duplex SC Connector

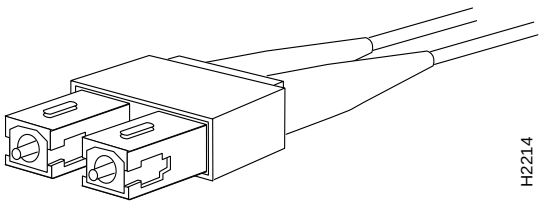
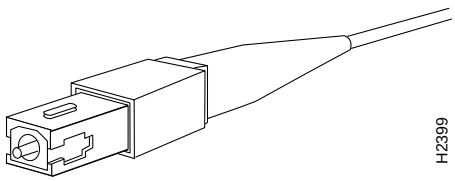


Figure 4-8 FE-FX Simplex SC Connector

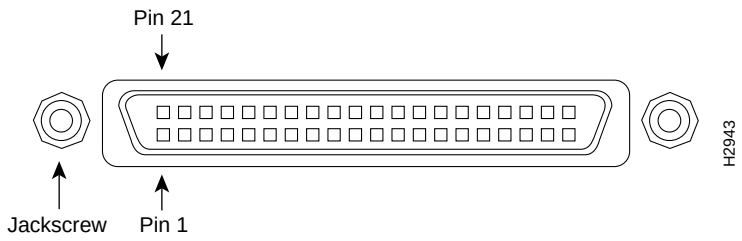


Depending on the type of media you use between the MII connection on the back card and your switch or hub, the network side of your 100BaseT transceiver should be appropriately equipped with ST-type connectors (for optical fiber), BNC connectors, and so forth. Figure 4-9 shows the pin orientation of the female MII connector on the back card. The back cards are field-replaceable units (FRUs).

The MII receptacle uses 2-56 screw-type locks, called *jackscrews* (see Figure 4-9), to secure the cable or transceiver to the MII port. MII cables and transceivers have knurled thumbscrews that you fasten to the jackscrews on the FE-TX back card's MII connector. Use the jackscrews to provide strain relief for the MII cable. Figure 4-9 also shows the MII female connector (receptacle).

Caution Before you attach your MII transceiver to the MII receptacle on your FE back card, ensure that your MII transceiver responds to physical sublayer (PHY) address 0 per section 22.2.4.4. “PHY Address” of the IEEE 802.3u specification; otherwise, interface problems might result. Confirm that this capability is available on the MII transceiver with the transceiver’s vendor or in the transceiver's documentation. If a selection for Isolation Mode is available, we recommend you use this setting (if no mention is made of PHY addressing).

Figure 4-9 FE-TX or FE-FX MII Connection (Receptacle Shown)



See Appendix B, “Cable and Connector Specifications” for the MII connector pinout and signals. MII cables are available commercially and are not available from Cisco Systems. The appendix refers to MII cables used between the MII connector on the FE-TX back card and an appropriate transceiver. The connection between this transceiver and your network can be Category 3, 4, or 5, 150-ohm UTP or STP, or multimode optical fiber.

Attaching FE Back Card Interface Cables

On a single FE back card, you can use *either* the RJ-45 (or SC for FE-FX) connection *or* the MII connection. (RJ-45, SC, and MII cables are not available from Cisco Systems; they are available from outside commercial cable vendors.) If you have two FE back cards, you can use the RJ-45 (or SC for FE-FX) connection on one back card and the MII connection on the other back card.

Caution Before you attach your MII transceiver to the MII receptacle on your FE back card, ensure that your MII transceiver responds to physical sublayer (PHY) address 0 per section 22.2.4.4. “PHY Address” of the IEEE 802.3u specification; otherwise, interface problems might result. Confirm that this capability is available on your MII transceiver with the transceiver’s vendor or in the transceiver's documentation. If a selection for Isolation Mode is available, we recommend you use this setting (if no mention is made of PHY addressing).

Use the following procedure to connect RJ-45, SC (FE-FX), or MII cables.

Step 1 Depending on the connection, do one of the following:

- If you have MII connections, attach an MII cable directly to the MII receptacle on the FE back card or attach a 100BaseT transceiver, with the media appropriate to your application, to the MII receptacle on the FE back card.
- If you have RJ-45 connections, attach the Category 5 UTP cable directly to the RJ-45 port on the FE back card. The FE back card is an end station device and not a repeater. You *must* connect the FE back card to a repeater or hub.

- If you have an SC connection (FE-FX back card), attach the cable directly to the SC port on the FE-FX back card. Use either one duplex SC connector or two simplex SC connectors, and observe the correct relationship between the receive (RX) and transmit (TX) ports on the FE-FX back card and your repeater.

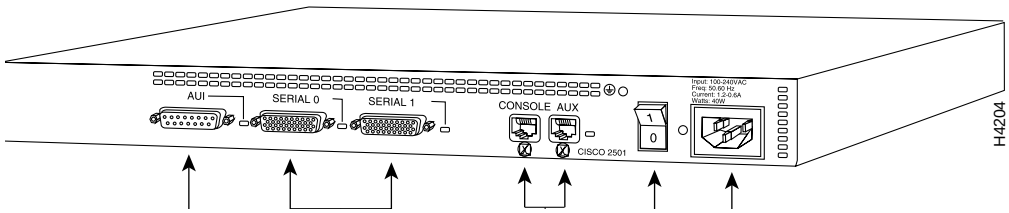
Note Each FE (FX or TX) back card can have *either* an MII attachment or an RJ-45 (or SC) attachment, but not both simultaneously. The MII and RJ-45 (or SC) receptacles represent two physical connection options for one Fast Ethernet interface.

Warning **Invisible laser radiation may be emitted from the aperture of the port when no cable is connected. To avoid exposure to laser radiation, do not stare into open apertures.**

Step 2 For the FE-TX, attach the ferrite bead to the RJ-45 cable (at either end), as shown in Figure 4-10.

Caution The ferrite bead prevents electromagnetic interference (EMI) from affecting the FE-TX-equipped system. It is a required component for proper system operation.

Figure 4-10 Attaching the Ferrite Bead around the RJ-45 Cable



Caution To prevent problems on your FE back card and network, do not simultaneously connect RJ-45 (or SC) *and* MII cables to one FE back card. On a single FE back card, only one network connection can be used at one time. Only connect cables that comply with EIA/TIA-568 standards.

Step 3 Attach the network end of your RJ-45 (SC) or MII cable to your 100BaseT transceiver, switch, hub, repeater, DTE, or other external 100BaseT equipment.

Note After your MII transceiver is connected and the FE interface is configured as up, you can verify that your MII transceiver responds to physical sublayer (PHY) address 0 by disconnecting the transceiver from the MII receptacle; if the FE interface goes down, then your MII transceiver responds to PHY address 0.

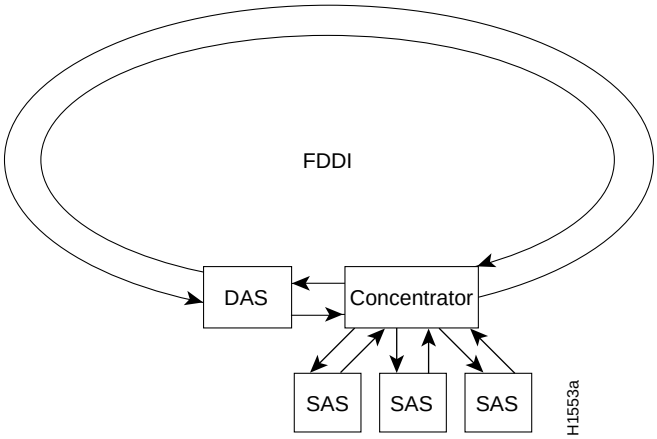
FDDI Back Cards for the RPM/B

FDDI, which specifies a 100-Mbps, wire-speed, token-passing dual-ring network using fiber-optic transmission media, is defined by the ANSI X3.1 standard and by ISO 9314, the international version of the ANSI standard. An FDDI network comprises two token-passing fiber-optic rings: a primary ring and a secondary ring.

A *ring* consists of two or more point-to-point connections between adjacent stations. On most networks, the primary ring is used for data communication, and the secondary ring is used as a backup. Single attachment stations attach to one ring and are typically attached through a concentrator; Class A, or dual attachment stations (DASs), attach to both rings.

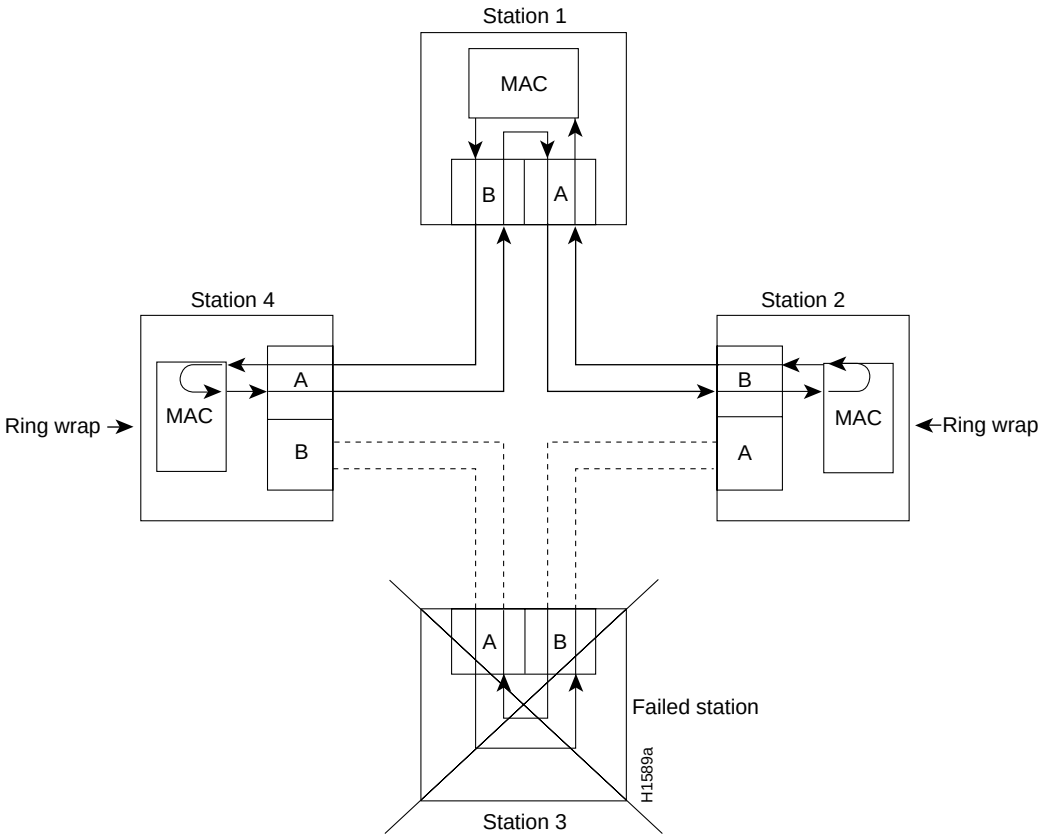
Figure 4-11 shows a typical FDDI configuration with both dual-attached and single-attached connections. Single attachment stations (SASs) typically attach to the primary ring through a concentrator, which provides connections for multiple single-attached devices. The concentrator ensures that a failure or power down of any single attachment station does not interrupt the ring. SASs use one transmit port and one receive port to attach to the single ring. DASs (Class A) have two physical ports, designated PHY A and PHY B, each of which connects the station to both the primary and secondary rings. Each port is a receiver for one ring and a transmitter for the other. For example, PHY A receives traffic from the primary ring and PHY B transmits to it.

Figure 4-11 Typical Configuration with DAS, Concentrator, and Single Attachment



The dual rings in an FDDI network provide fault tolerance. If a station on a dual ring shuts down or fails, such as Station 3 in Figure 4-12, the ring automatically wraps (doubles back on itself) to form a single contiguous ring. This removes the failed station from the ring, but allows the other stations to continue operation. In Figure 4-12, the ring wraps to eliminate Station 3 and forms a smaller ring that includes only Stations 1, 2, and 4. A second failure could cause the ring to wrap in both directions from the point of failure, which would segment the ring into two separate rings that could not communicate with each other.

Figure 4-12 DAS Station Failure and Ring Recovery Example



For example, if Station 1 in Figure 4-12 fails after Station 3 fails, Stations 2 and 4 will each be isolated because no path for communication exists between them. Subsequent failures cause additional segmentation.

Optical Bypass Overview

This section includes information on optical bypass switching with FDDI.

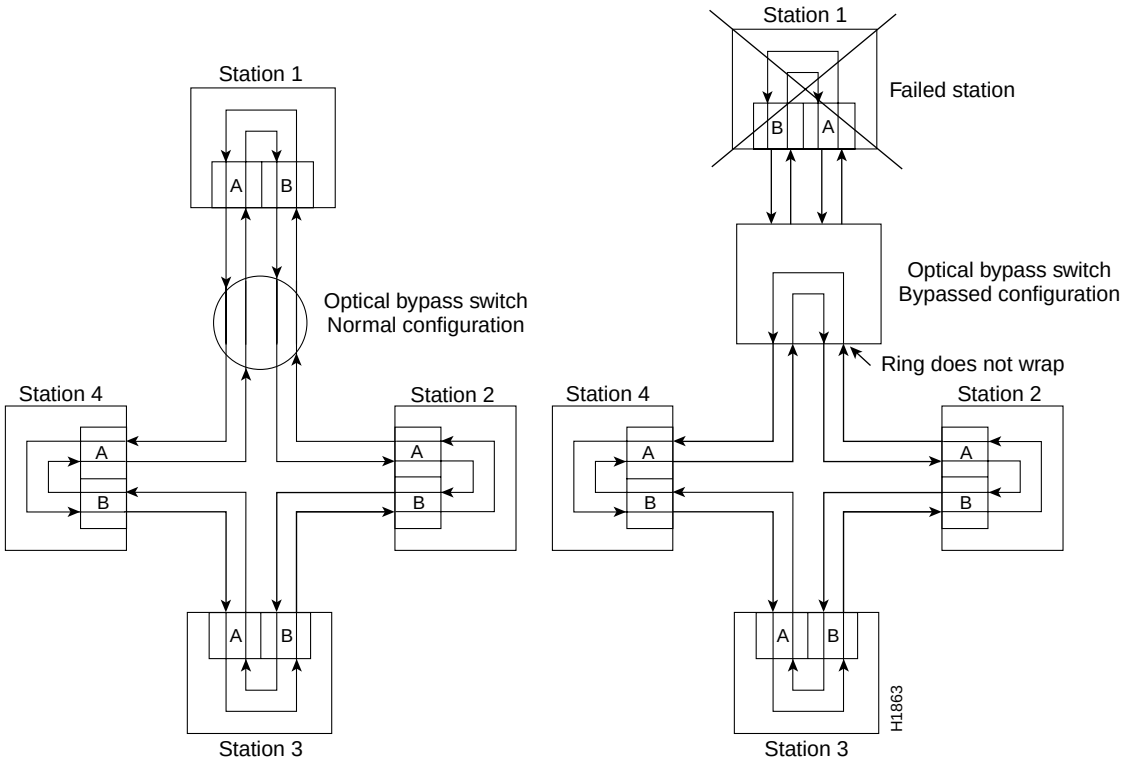
Optical bypass switching avoids segmentation by eliminating failed stations from a ring. An optical bypass switch allows the light signal to pass directly through it, completely bypassing the failed or shut down station.

For example, if an optical bypass switch was installed at Station 3 in the example ring, it would allow the light signal to pass through the switch and maintain its existing path and direction without wrapping back on itself.

The FDDI back cards have an optical bypass switch feature by way of a DIN connection. Optical bypass switches avoid segmentation by eliminating failed stations from the ring. During normal operation, an optical bypass switch allows the light signal to pass uninterrupted directly through itself. When a station with a bypass switch fails, the bypass switch reroutes the signal back onto the ring before it reaches the failed station, so the ring does not have to wrap back on itself.

Figure 4-13 shows an optical bypass switch installed at Station 1. In the normal configuration shown, Station 1 is functioning normally, so the optical bypass switch appears transparent. The switch essentially allows the signals to pass through it without interruption. However, if Station 1 fails, the optical bypass switch enables the bypassed configuration shown on the right.

Figure 4-13 Optical Bypass Operation on a DAS



The optical bypass switch reroutes the light signal by intercepting it before it reaches the failed Station 1 and sends it back out to the ring, allowing the signal to maintain its existing path and direction without wrapping back on itself. However, stations that are operating normally repeat the signal when sending it back out to the ring. Optical bypass switches do not repeat or drive the signal (they just allow the signal to pass through them), so significant signal loss can occur when the downstream neighbor (the next station on the ring) is far away.

Another technique for fault tolerance is *dual homing*, whereby critical devices are attached to two concentrators. Only the designated primary concentrator is active unless it (or its link) fails. If the primary fails, the backup (passive) concentrator is automatically activated and sustains the ring.

FDDI Specifications

Typically, FDDI uses two types of fiber-optic cable:

- Single-mode (also called monomode) optical fiber with SC-type, duplex and simplex connectors
- Multimode optical fiber with MICs

Mode refers to the angle at which light rays (signals) are reflected and propagated through the optical fiber core, which acts as a waveguide for the light signals. Multimode fiber has a relatively thick core (62.5/125-micron) that reflects light rays at many angles. Single-mode fiber has a narrow core (8.7 to 10/125-micron) that allows the light to enter only at a single angle.

Although multimode fiber allows more light signals to enter at a greater variety of angles (modes), the different angles create multiple propagation paths that cause the signals to spread out in time and limits the rate at which data can be accurately received. This distortion does not occur on the single path of the single-mode signal; therefore, single-mode fiber is capable of higher bandwidth and greater cable run distances that multimode fiber. In addition, multimode transmitters usually use LEDs as a light source, and single-mode transmitters use a laser diode, which is capable of sustaining faster data rates. Both types use a photodiode detector at the receiver to translate the light signal into electrical signals.

The FDDI standard sets total fiber lengths of 2 kilometers (1.2 miles) for multimode fiber and 15 kilometers (9.3 miles) for single-mode fiber. (The maximum circumference of the FDDI network is only half the specified distance because of signal wrapping or loopback that occurs during fault correction.) The FDDI standard allows a maximum of 500 stations with a maximum distance between active stations of 2 kilometers.

See Appendix B, "Cable and Connector Specifications," for a description of the mini-DIN optical bypass switch available on the FDDI back cards. The mini-DIN-to-DIN adapter cable (CAB-FMDD=) allows a connection to an optical bypass switch with a DIN connector (which is larger than the mini-DIN connector on the FDDI back cards).

Note Up to 160 milliamperes (mA) of current can be supplied to the optical bypass switch.

The FDDI back card implementation complies with Version 6.1 of the X3T9.5 FDDI specification, offering a Class A dual attachment interface that supports the fault-recovery methods of DAS. The FDDI back card supports dual homing and optical bypass and complies with ANSI X3.1 and ISO 9314 FDDI standards.

Maximum Transmission Distances for FDDI Connections

The maximum transmission distances for single-mode and multimode FDDI stations are shown in Table 4-5. If the distance between two connected stations is greater than the maximum distance shown, significant signal loss can result.

Table 4-5 FDDI Maximum Transmission Distances

Transceiver Type	Maximum Distance Between Stations
Single-mode	Up to 9.3 miles (15 km)
Multimode	Up to 1.2 miles (2 km)

FDDI Back Card Optical Power Parameters

The multimode and single-mode optical-fiber connections conform to the following optical power parameters:

- Output power: –19 to –14 dBm
- Input power: –31 to –14 dBm
- Input sensitivity: –31 dBm @ 2.5×10^{-10} BER @ 125 Mbps

FDDI Back Card

The FDDI back cards provide a half-duplex FDDI for both single-mode and multimode fiber-optic cable. The two physical ports (PHY A and PHY B) are available with either single-mode (SC) or multimode MIC receptacles. Each back card's FDDI connection allows a maximum bandwidth of 100 Mbps per the FDDI standard.

The following FDDI back card combinations are available:

- PA-F-MM—FDDI PHY-A multimode, PHY-B multimode back card with optical bypass switch capability
- PA-F-SM—FDDI PHY-A single-mode, PHY-B single-mode back card with optical bypass switch capability

Warning **Invisible laser radiation may be emitted from the aperture ports of the single-mode FDDI products when no fiber cable is connected. *Avoid exposure and do not stare into open apertures*.**

FDDI Back Card LEDs

This section describes the functions of the LEDs on the half-duplex FDDI back cards.

The FDDI back card contains the enabled LED, standard on all back cards, and status LEDs for each port. After system initialization, the enabled LED goes on to indicate that the FDDI back card has been enabled for operation. The LEDs on both half-duplex FDDI back cards are identical.

The following conditions must be met before the enabled LED goes on:

- FDDI back card is correctly connected and receiving power.
- FDDI-equipped card or chassis contains a valid microcode version that is downloaded successfully.
- Bus recognizes the FDDI-equipped card or chassis.

If any of these conditions is not met, or if the initialization fails for other reasons, the enabled LED does not go on. In addition to the enabled LED, the FDDI back card has the following three LEDs:

- PHY-A—This green LED is on when the PHY A connection is active on the FDDI ring.
- PHY-B—This green LED is on when the PHY B connection is active on the FDDI ring.
- DUAL HOME—This green LED is on when the FDDI station is dual homed.

The states of the back card's LEDs and the meanings of each are described in Table 4-6.

Table 4-6 FDDI Back Card LED States

PA-F-MM and PA-F-SM LEDs[1]			Indication
PHY A	**PHY B**	**Dual-Homed**	
—	—	—	Not connected
—	—	O	Not possible
—	O	—	Wrap B
—	O	O	Dual homed (B connected to M port)
O	—	—	Wrap A

Table 4-6 FDDI Back Card LED States (continued)

PA-F-MM and PA-F-SM LEDs[1]			Indication
PHY A	PHY B	Dual-Homed	
O	—	O	Dual homing back-up (A connected to M port; B port is not connected)
O	O	—	Through A
O	O	O	Not possible

1. For the LED patterns "—" means off, "O" means on.

FDDI SMF Back Card Fiber-Optic Cables

This section describes the half-duplex FDDI back card receptacles and cables.

The interface receptacles on the FDDI back card use SC-type connectors for simplex and duplex, single-mode applications. For FDDI single-mode connections, use one duplex SC connector (see Figure 4-14) or two single SC connectors, at both the back card end and the network end (see Figure 4-15). Single-mode optical fiber cable has a narrow core (8.7 to 10/125-micron) that allows light to enter only at a single angle.

Figure 4-14 Duplex SC Connector

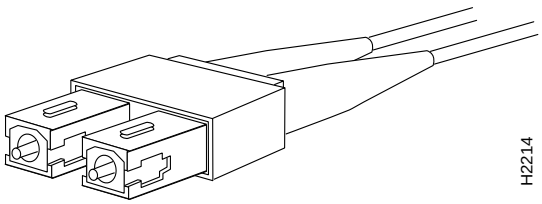
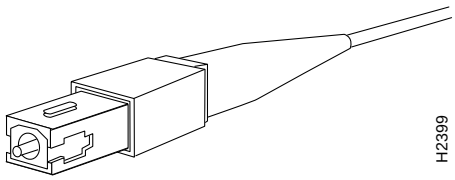


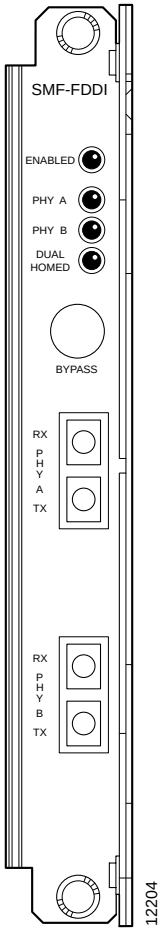
Figure 4-15 Simplex SC Connector



Warning **Invisible laser radiation may be emitted from the aperture ports of the single-mode FDDI products when no fiber cable is connected. *Avoid exposure and do not stare into open apertures*.**

Figure 4-16 shows a view of the FDDI SMF back card.

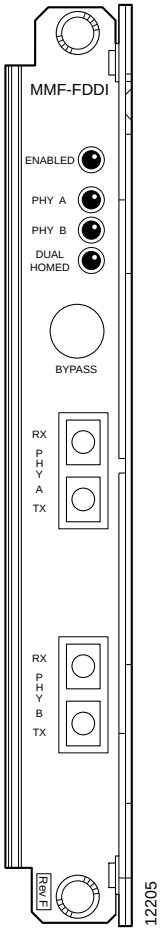
Figure 4-16 FDDI SMF Back Card



FDDI MMF Back Card

Figure 4-17 shows a view of the FDDI MMF back card.

Figure 4-17 FDDI MMF Back Card



FDDI Back Card LEDs

This section describes the functions of the LEDs on the half-duplex FDDI back cards.

The FDDI back card contains the enabled LED, standard on all back cards, and status LEDs for each port. After system initialization, the enabled LED goes on to indicate that the FDDI back card has been enabled for operation. The LEDs are shown in Figure 4-16 and Figure 4-17. The LEDs on both half-duplex FDDI back cards are identical.

The following conditions must be met before the enabled LED goes on:

- FDDI back card is correctly connected and receiving power.
- FDDI-equipped card or chassis contains a valid microcode version that has been downloaded successfully.
- Bus recognizes the FDDI-equipped card or chassis.

If any of these conditions is not met, or if the initialization fails for other reasons, the enabled LED does not go on. In addition to the enabled LED, the FDDI back card has the following three LEDs:

- PHY-A—This green LED is on when the PHY A connection is active on the FDDI ring.
- PHY-B—This green LED is on when the PHY B connection is active on the FDDI ring.

- DUAL HOME—This green LED is on when the FDDI station is dual homed.

The states of the back card's LEDs and the meanings of each are described in Table 4-7.

Table 4-7 FDDI Back Card LED States

PA-F-MM and PA-F-SM LEDs[1]			Indication
PHY A	PHY B	Dual-Homed	
—	—	—	Not connected
—	—	O	Not possible
—	O	—	Wrap B
—	O	O	Dual homed (B connected to M port)
O	—	—	Wrap A
O	—	O	Dual homing back-up (A connected to M port; B port is not connected)
O	O	—	Through A
O	O	O	Not possible

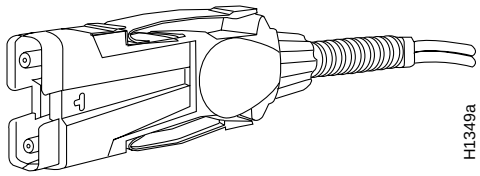
1. For the LED patterns "—" means off, "O" means on.

FDDI MMF Back Card Fiber-Optic Cables

This section describes the half-duplex FDDI back card receptacles and cables.

The interface receptacles on the FDDI back card are MICs for multimode applications. The multimode receptacle is an FDDI-standard physical sublayer (PHY) connector that encodes and decodes the data into a format acceptable for fiber transmission. The multimode receptacle accepts standard 62.5/125-micron, multimode fiber-optic cable using the MIC and, with proper cable terminators, can accept 50/125 micron fiber-optic cable. Fiber-optic cables are commercially available and are not available from Cisco Systems. Multimode uses the integrated MIC shown in Figure 4-18, at both the back card end and the network end.

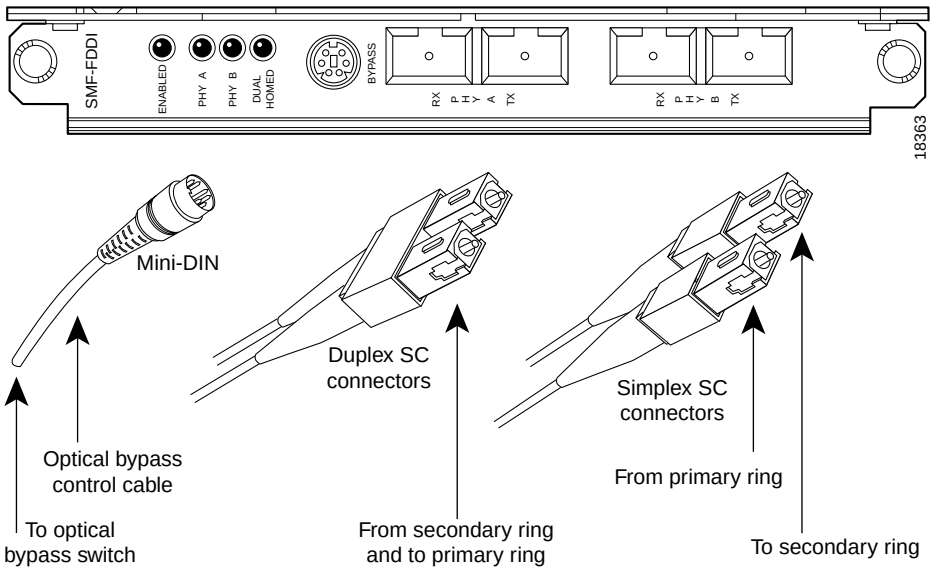
Figure 4-18 Multimode FDDI Network Interface MIC



Attaching FDDI Back Card Interface Cables

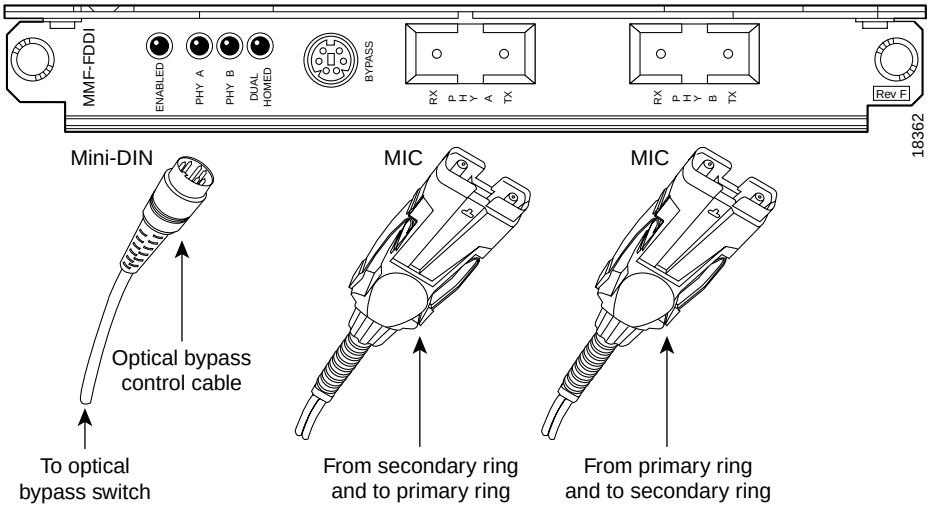
Both single-mode and multimode, dual attachment cable connections are available. Fiber-optic cable connects directly to the FDDI ports. Single-mode uses simplex or duplex SC-type transmit and receive cables. Connect single-mode, dual attachment as shown in Figure 4-19.

Figure 4-19 Single-Mode Dual Attachment with Duplex and Simplex SC-Type Cables and Optical Bypass Control Cable



Multimode uses MIC cables. Connect multimode with Fixed Shrouded Duplex connector as shown in Figure 4-20.

Figure 4-20 Multimode Dual Attachment with MIC Cables and Optical Bypass Control Cable



Attaching an Optical Bypass Switch

An optical bypass switch is a device installed between the ring and the station that provides additional fault tolerance to the network. If an FDDI back card that is connected to a bypass switch fails or shuts down, the bypass switch activates automatically and allows the light signal to pass directly through it, bypassing the back card completely.

Following are general instructions for connecting an optical bypass switch to the FDDI back card; however, your particular bypass switch may require a different connection scheme. Use these illustrations and general guidelines. For specific connection requirements, refer to the instructions provided by the manufacturer of the optical bypass switch.

- Connect the bypass switch to the ring. Unless the documentation that accompanies the bypass switch instructs otherwise, observe the same guidelines for connecting the A/B ports on the bypass switch that you would to connect the ring directly to the FDDI ports. Use the receive label on the cable connectors as a key and connect the multimode or single-mode cables to the network (ring) side of the bypass switch as follows:
  - Connect the cable coming in from the primary ring (*from* PHY B at the preceding station) to the PHY A receive port on the network (ring) side of the bypass switch. This also connects the signal going out to the secondary ring to the PHY A transmit port.
  - Connect the cable coming in from the secondary ring (*from* PHY A at the preceding station) to the PHY B receive port on the network (ring) side of the bypass switch. This also connects the signal going out to the primary ring to the PHY B transmit port.
- Connect the bypass switch to the back card. Unless the documentation that accompanies the bypass switch instructs otherwise, consider the bypass an extension of the FDDI ports and connect A to A and B to B. The network cables are already connected to the bypass switch following the standard B-to-A/A-to-B scheme.
  - Connect an interface cable between the PHY A port on the station (back card) side of the bypass switch and the FIP PHY A port.
  - Connect an interface cable between the PHY B port on the station (back card) side of the bypass switch and the FIP PHY B port.
- Connect the bypass switch control cable. If the control cable on your optical bypass switch uses a mini-DIN connector, connect the cable directly to the female mini-DIN optical bypass port on the FDDI back card. If the switch uses a standard DIN connector, use the optical bypass adapter cable (CAB-FMDD=) supplied with each FDDI back card. Connect the DIN end of the adapter cable to the DIN on the control cable, and connect the mini-DIN end of adapter cable to the mini-DIN optical bypass port on the FDDI back card.

A port for connecting an optical bypass switch is provided on the multimode back card (PA-F/FD-MM, shown in Figure 4-21), and the single-mode back card (PA-F/FD-SM, shown in Figure 4-22).

Figure 4-21 Optical Bypass Switch Connection (PA-F/FD-MM)

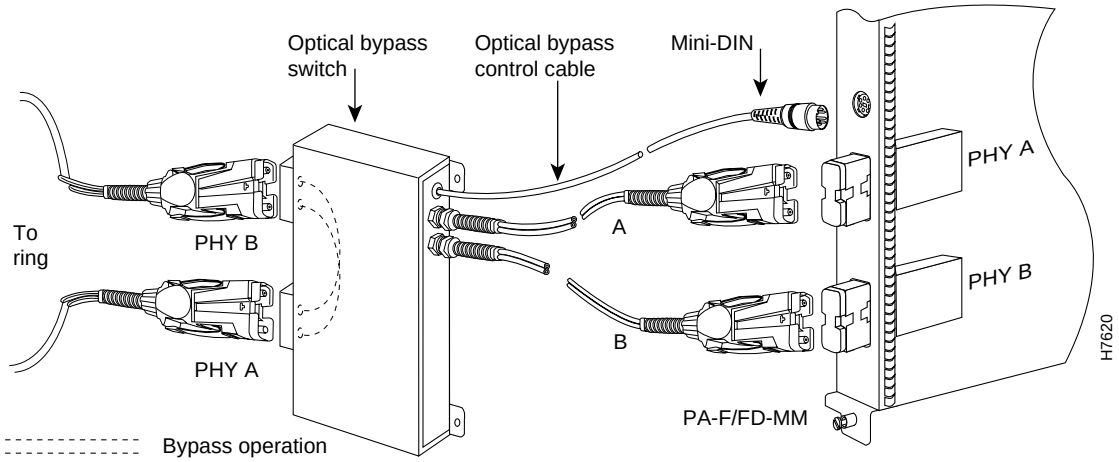
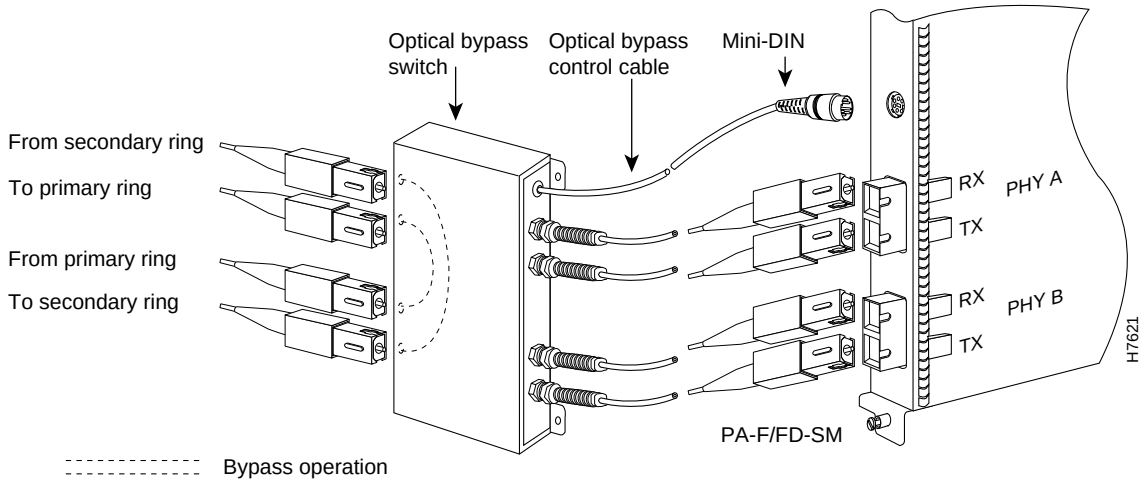


Figure 4-22 Optical Bypass Switch Connection (PA-F/FD-SM



Note Up to 160 milliamperes of current can be supplied to the optical bypass switch.

Configuring the MGX RPM

This chapter describes how to complete a basic configuration of the MGX Route Processor Module (RPM). It provides procedures for configuring the ATM port adapter and Ethernet, Fast Ethernet and FDDI (for the RPM/B) back card interfaces and permanent virtual circuits (PVCs). For details on how to make connections between an RPM and a PXM and among either service modules or other RPMs, see Chapter 6, "Setting Up Connections Between Other Devices and the RPM." The chapter contains the following sections:

- Accessing the RPM Command Line Interface
- Booting the RPM
- Configuring the RPM
- Configuring the RPM
- Configuring Back Card Interfaces
- Checking the Configuration
- Configuration Mode
- Verifying Network Connectivity
- Specifying the Boot Method
- Configuring Permanent Virtual Circuits on the RPM
- Establishing 1:N Redundancy Between Two or More RPM Cards

This chapter provides information necessary to get the RPM up and running. Detailed software configuration information is available in Cisco IOS configuration and command reference publications, which are available on the Cisco Documentation CD-ROM and online.

Accessing the RPM Command Line Interface

To configure the RPM, you must access the command line interface (CLI) of the RPM.

The RPM CLI can be accessed using any of the following methods:

- Console port on the front of the RPM

  The RPM has an RJ-45 connector on the front of the card module. If you configure the RPM on site, connect a console terminal (an ASCII terminal or a PC running terminal emulation software) directly to the console port on your RPM using an RS-232 to RJ-45 cable for CLI access (see Chapter 3, "Installing the MGX RPM").

Note The console port is the only way to access the RPM CLI when the card module is first installed into an MGX 8850 chassis.

- **cc** from another MGX 8850 card

  After initial configuration, you can also configure the RPM through the PXM. You can access the RPM CLI by entering the **cc** (change card) command from any of the other cards.

- Telnet from a workstation, PC, or another router

  After initial configuration, you can also configure the RPM remotely via telnet. After the RPM is installed and has PVCs to other RPMs or routers in the network, you can telnet to the RPM CLI remotely from these other devices.

  To connect a modem to the auxiliary port on the RPM see Chapter 3, "Installing the MGX RPM."

Booting the RPM

When the RPM is booted, the boot image must be the first file in the bootflash. If the bootflash does not have a valid boot image as a first file, the card may not be able to boot and can result in bootflash corruption. If the bootflash is corrupted, you will have to send the card back for an external burn with a valid boot image.

You can reboot the RPM from the PXM by entering the command **resetcd** <*card_number*> from the switch CLI, where *card_number* is the slot number of the RPM that is being rebooted.

Note Omitting the card number resets the entire system.

Also, you can reboot the RPM from the RPM using the RPM console port and entering the **reload** command.

Each time you turn on power to the RPM by inserting the RPM into the MGX 8850, it goes through the following boot sequence:

1. The RPM runs diagnostics on the CPU, memory, and interfaces.
2. The system bootstrap software, which is the boot image, executes and searches for a valid Cisco IOS image, which is the RPM runtime software.

   The source of the Cisco IOS image is determined by the configuration register setting. To verify this setting, you can enter either the **show version** or **show bootvar** command. (See the "Viewing the Hardware Configuration" section later in this chapter.)

- If the configuration register is set to the factory-default setting of **0x01**, RPM will come up and stay in boot mode.
- If the configuration register is **0x2**, the RPM will look for the runtime image either in bootflash or on the PXM C:RPM drive.

3. The search for runtime image is determined by which boot system command is entered.

- Entering the **boot system c:**<*runtime_image_name*> command will result in a search for a runtime image on the PXM C:RPM drive.
- Entering the **boot system bootflash:**<*runtime_image_name*> command will result in a search for a run time image in the bootflash.

4. If the runtime software is not found after three attempts, the RPM reverts to the boot mode.
5. If a valid Cisco IOS image is found, then the RPM searches for a valid configuration, which can reside in NVRAM or as a configuration file either on the PXM hard disk C: drive or in bootflash.

   If you want to load from a specific configuration file, you should enter either the **boot config bootflash:**<*config_file*> command or the **boot config c:<config_file**> command.
6. For normal RPM operation, there must be a valid Cisco IOS image on the PXM C: drive or in bootflash, and a configuration in NVRAM or configuration file in bootflash or on the PXM disk.

   The first time you boot the RPM, configure the RPM interfaces and save the configuration to a file in NVRAM. Then follow the procedure described in "Initializing the RPM Card." For information on the Cisco IOS instructions, see Appendix C, "IOS and Configuration Basics."

RPM Bootflash Precautions

The RPM bootflash is used to store boot image, configuration and "run time" files. The Flash stores and accesses data sequentially, and the RPM boot image must be the first file stored to successfully boot the card. Erasing the boot image or moving it from the first position on the Flash will cause the card to not boot.

The RPM boot image, which comes loaded on the Flash, will work for all RPM IOS images. Therefore, there is no reason to ever delete or move the factory installed boot image.

Note Erasing or moving the boot image can cause RPM boot failure. When this happens, the RPM must be returned to Cisco and reflashed.

In order to avoid this unnecessary failure, requiring card servicing, you should

- Never erase the boot file from the RPM Flash
- Never change the position of the boot file on the RPM Flash
- Use care when "squeezing" the Flash to clean it up.

As long as the boot file remains intact in the first position on the flash, the RPM will successfully boot.

Verifying the IOS Files on Bootflash

Enter the **show bootflash** command to verify the IOS files on the bootflash. The following screen displays the RPM command sequence.

```
Router#show bootflash:

-#- ED --type-- --crc--- -seek-- nlen -length- -----date/time------ name
1   .. image    AB6CF374  2BAFB4   11  2600756 Jul 25 2001 02:41:41 rpm-boot-mz
2   .. config   44E48EC2  34712C   18   573685 Aug 07 2001 23:03:42 auto_config_slot16
3   .. config   7B53E8DC  40E368   18   815547 Aug 08 2001 19:28:03 auto_config_slot15

28777624 bytes available (3990376 bytes used)
Router#
```

Verifying the IOS Files on the PXM C: Drive

The IOS image can be stored on the PXM hard drive. To confirm this, make sure you are in the C:RPM directory. Enter the **ll** command to list the contents of the directory. You should see a file with a name beginning with **rpm-js-mz**, which is the IOS image.

Tip Copy the RPM Cisco IOS image into the RPM directory of the PXM hard disk with the filename specified in the RPM boot command.

The following screen displays the PXM C:RPM content listing.

```
8850_NY.7.PXM.a > cd C:RPM

8850_NY.7.PXM.a > ll
  size          date       time       name
--------       ------     ------    --------
     512    FEB-23-2001  17:59:54   .                 <DIR>
     512    FEB-23-2001  17:59:54   ..                <DIR>
 2621276    FEB-23-2001  15:46:36   rpm-boot-mz.122-3.6.T1
 8585684    FEB-23-2001  20:32:34   rpm-js-mz.122-3.6.T2
     744    FEB-27-2001  10:24:22   auto_config_slot11

In the file system :
    total space :  102400 K bytes
    free  space :  91984 K bytes

8850_NY.7.PXM.a >
```

Initializing the RPM Card

The first time you boot the RPM card, you must boot it from flash memory as shown in the following procedure, then copy the IOS image on the PXM to the RPM. Refer to the *Cisco MGX 8850 Multiservice Switch Software Configuration Guide*, *Cisco MGX 8250 Edge Concentrator Installation and Configuration*, and *Cisco MGX 8230 Edge Concentrator Installation and Configuration* for instructions on copying files.

Step 1 From the switch CLI, enter **cc** <*RPM card slot #*> to access the router card.

The router prompt (>) appears

Step 2 Enter **enable** and your password when prompted, so that you can enter privileged commands.

Step 3 Enter **dir** to display the flash memory directory as shown here, and note the boot image software version.

```
Router#dir
Directory of bootflash:/

    1  -rw-     2621276   Feb 22 2001 18:28:03  rpm-boot-mz.122-3.6.T1
    2  -rw-         553   Feb 22 2001 16:18:34  auto_config_slot10
```

Step 4 Enter **dir c:** to display the contents of the C:RPM directory on the PXM hard drive. Note the runtime image filename for Step 7.

```
Router#dir c:
Directory of c:/

65540  -rw-     2621276   Feb 23 2001 19:13:10  rpm-boot-mz.122-3.6.T1
66738  -rw-     8585684   Feb 23 2001 19:15:24  rpm-js-mz.122-3.6.T2
```

Step 5 Enter **configure terminal** at the prompt to enable the RPM interface.

```
Router#configure terminal
```

Step 6 Enter **no boot system** to clear any existing boot system commands.

```
Router(config)#no boot system
```

Step 7 The RPM can be booted from either the bootflash or PXM hard disk, by entering either,

boot system bootflash:< *filename*> to load the runtime software from the bootflash
or
boot system c:< *filename*> to load the runtime software from the PXM hard disk

Step 8 Enter **end** or press **Ctrl Z** to exit the configuration interface mode.

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

Step 9 Enter **copy run start** to save the configuration.

```
Router#copy run start
```

Step 10 Enter **reload** on the RPM.

```
Router#reload
```

To verify the version, enter the **show version** or **show diag** commands. See the "Viewing the Hardware Configuration" section later in this chapter.

Assigning an IP Address to the Switch Interface

You need to assign an IP address for the RPM on the ATM switch. This procedure tells you how to configure the ATM switch interface with the IP address.

Timesaver Obtain the correct IP and ATM network addresses for your RPM on the ATM switch from your system administrator or consult your network plan to determine correct addresses before you continue to configure the RPM.

Step 1 Enter **show ip int brief** to display your router IP interfaces.

```
Router#show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
Switch1                    unassigned      YES NVRAM  up                    up
```

Note that the switch does not have an assigned IP address.

Step 2 Enter **conf terminal** to enter global configuration mode.

```
Router#conf terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3 To enter interface configuration mode for the ATM interface, enter **interface switch1** at the prompt.

```
Router(config)#interface switch1
```

Step 4 Enter **ip address** followed by the IP address to be assigned to the ATM switch.

```
Router(config-if)#ip address 1.1.1.1 255.255.255.0
```

Step 5 Enter **end** or press **Ctrl-Z** to exit the configuration interface mode.

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

Step 6 Enter **show ip int brief** to display the IP address assigned to the ATM switch. The following screen is an example.

```
Router#show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
Switch1                    1.1.1.1         YES manual up                    up
```

Note that the newly added interface address appears in the display.

Step 7 Enter **show run** to verify the configuration of the RPM, as shown in the following example screen.

```
Router#show run

Building configuration...

Current configuration : 729 bytes
!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
boot system c:rpm-js-mz.122-3.6.T2
boot config c:auto_config_slot11
logging rate-limit console 10 except errors
enable password cisco
!
ip subnet-zero
no ip finger
!
no ip dhcp-client network-discovery
!
!
!
interface Switch1
 ip address 1.1.1.1 255.255.255.0
 no atm ilmi-keepalive
 switch autoSynch off
!
ip kerberos source-interface any
ip classless
no ip http server
!
!
!
line con 0
 transport input none
line aux 0
line vty 0 4
 no login
!
end
```

Step 8 Enter **copy run start** at the prompt to write the configuration to the router NVRAM memory.

```
Router#copy run start
Building configuration...
[OK]
```

The IP address is now active and ready to use.

Booting the RPM From the PXM C: Drive

The IOS image should be stored on the PXM hard drive. To confirm this, make sure you are in the /RPM directory and use the **ls** command to list the contents of the directory. You should see the RPM IOS image as shown in the example below. The following example displays the PXM commands illustrating this command sequence:

```
NODENAME.1.7.PXM.a > cd C:RPM

NODENAME.1.7.PXM.a > ls
.
..
rpm-boot-mz.122-3.6.T1
rpm-js-mz.122-3.6.T2

In the file system :
    total space : 3176712 K bytes
    free  space : 3067819 K bytes

NODENAME.1.7.PXM.a >
```

If the image is not there, you will need to use the TFTP file-transfer application to load the image to the PXM hard drive.

The following example displays a TFTP sequence:

```
marka-u5:4> ls -l rpm-js-mz.122-3.6.T2
-rw-r--r--   1 marka    eng       4560820 Apr  2 12:16 rpm-is-mz.120-4.0.1.T
marka-u5:5> tftp 172.29.37.154
tftp> bin
tftp> put rpm-js-mz.122-3.6.T2 RPM/rpm-js-mz.122-3.6.T2
Sent 4560820 bytes in 41.2 seconds
tftp> q
marka-u5:6>
```

To load the IOS image from the PXM hard drive, the RPM must be configured.

Tip Put the RPM's Cisco IOS image in the RPM directory of the PXM hard disk with the filename specified in the RPM **boot** command.

To verify the accessibility of the PXM C: drive from the RPM, enter the following privileged-level EXEC command:

```
MGX8850-RPM# dir c:
Directory of c:/

     -rw-     5584092   Oct 19 1999 15:39:54  rpm-js-mz.122-3.6.T2
     -rw-     1680448   Oct 19 1999 15:39:54  rpm-boot-mz.122-3.6.T1
```

```
No space information available

********
```

Enter the **boot system** command to override the default boot setting and to configure the RPM to boot from the PXM:

```
MGX8850-RPM (config)# boot system c:filename
```

Enter the **write memory** command to save the configuration on the NVRAM:

```
MGX8850-RPM# write memory
```

Reload the RPM and boot the Cisco IOS from the PXM disk.

Configuring the RPM

You can configure the RPM using Configuration Mode. This method is recommended if you are familiar with the Cisco IOS commands.

Timesaver Obtain the correct network addresses from your system administrator or consult your network plan to determine correct addresses before you configure the RPM.

If you would like a quick review of the Cisco IOS software, see the "Establishing 1:N Redundancy Between Two or More RPM Cards" section later in this chapter.

Configuring Back Card Interfaces

Once back card cable connections are made (see Chapter 4, "Cabling the MGX RPM Back Cards" for connector descriptions and cable attachment instructions) and basic configuration on the RPM is completed, Ethernet, Fast Ethernet, and FDDI back card interfaces on the RPM must be configured. This is then followed by the configuration of the permanent virtual circuits (PVCs) and the connections between the RPM and the PXM and either service modules or other RPMs.

Preparing to Configure Back Card Interfaces

If you want to configure interfaces in a new RPM or change the configuration of an existing interface, you will need the following information:

- Protocols you plan to route on each new interface.
- Internet protocol (IP) addresses if you plan to configure the interfaces for IP routing.
- Whether the new interfaces will use bridging.
- Whether the new interfaces will use LAN.

The **configure** command requires privileged-level access to the EXEC command interpreter, which usually requires a password. Contact your system administrator to obtain EXEC-level access.

Back Card Bay and Interface Port Numbers

This section describes how to identify the back card bay and interface port numbers on the RPM for all back card interface types.

Physical port addresses specify the physical location of each interface port, regardless of the type, on the RPM. In the RPM, this address is composed of a two-part number in the form *<interface bay number/interface port number>*, as follows:

- *<interface bay number>* identifies the bay in which the back card is installed, either upper (1) or lower (2) bay.
- *<interface port number>* identifies the interface port(s) on the back card. FE cards have one interface number. 4E/B cards have four numbered interfaces.

For example, the following command specifies interface port 1 of the upper Ethernet back card in the RPM. You need to enter this information to select a specific port on a back card or ATM interface.

```
Router(config)#interface fastEthernet 1/1
```

Also, you can identify interface ports by checking the bay/interface port location on the body of the RPM or by using **show** commands to display information about a specific interface or all interfaces in the RPM.

Configuring 4E and 4E/B Interfaces

The Ethernet interfaces are configured to allow a connection to a LAN. To configure the interface parameters, you need to know your Ethernet interface network addresses.

The following procedure displays how to configure an Ethernet interface to allow communication over a LAN.

Step 1 At the privileged-level prompt, enter configuration mode and specify that the console terminal will be the source of the configuration subcommands, as follows:

```
RPM-3# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
RPM-3(config)#
```

Step 2 At the prompt, enter the subcommand **interface** to specify the interface to be configured, followed by **ethernet** to specify back card type, then *bay/port* (for the bay of the MGX 8850 where the RPM resides, upper (1) or lower (2) back card, and for port number on the back card).

Note The 4E and 4E/B interfaces are numbered 1, 2, 3, 4 and not 0, 1, 2, 3 as in other IOS platforms.

In this procedure, the 2 interface of the lower ethernet back card in the RPM in slot 5 of the MGX 8850 are used as an example.

```
RPM-3(config)# interface e 2/2
```

Step 3 If IP routing is enabled on the system, you can assign an IP address and subnet mask to the interface with the **ip address** configuration subcommand, as in this example:

```
RPM-3(config-int)# ip address 1.1.1.10 255.255.255.0
```

Step 4 Add any additional configuration subcommands required to enable routing protocols and set the interface characteristics.

Step 5 Change the shutdown state to up and enable the interface as follows:

```
RPM-3(config-int)# no shutdown
```

Step 6 Configure additional interfaces as required.

Step 7 When you have included all of the configuration subcommands to complete the configuration, press **Ctrl-Z** to exit configuration mode.

Step 8 Write the new configuration to nonvolatile memory as follows:

```
RPM-3# copy running-config startup-config
[OK]
RPM-3#
```

To check the interface configuration using **show** commands, proceed to the section "Checking the Configuration."

Configuring FE Interfaces

The following procedure describes a basic fast ethernet configuration.

Step 1 At the privileged-level prompt, enter configuration mode and specify that the console terminal will be the source of the configuration subcommands, as follows:

```
RPM-3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
RPM-3(config)#
```

Step 2 At the prompt, enter the subcommand **interface** to specify the interface to be configured, followed by **fastethernet** to specify back card type, then *bay/port* (for the bay of the MGX 8850 where the RPM resides, upper (1) or lower (2) back card, and for port number on the back card).

In this procedure, the 1 interface of the upper fastethernet back card in the RPM in slot 5 of the MGX 8850 is used as an example.

```
RPM-3(config)# interface fastethernet 1/1
```

Step 3 If IP routing is enabled on the system, you can assign an IP address and subnet mask to the interface with the **ip address** configuration subcommand, as in the following example:

```
RPM-3(config-if)# ip address 1.1.1.10 255.255.255.0
```

Step 4 Add any additional configuration subcommands required to enable routing protocols and set the interface characteristics.

Step 5 Change the shutdown state to up and enable the interface as follows:

```
RPM-3(config-if)# no shutdown
```

Step 6 Configure additional interfaces as required.

Step 7 When you have included all of the configuration subcommands to complete the configuration, press **Ctrl-Z** to exit configuration mode.

Step 8 Write the new configuration to nonvolatile memory as follows:

```
RPM-3# copy running-config startup-config
[OK]
RPM-3#
```

This completes the procedure for creating a basic configuration.

Half-duplex operation is the default transmission mode for the FE back cards. Enter the **full-duplex** command to configure full-duplex operation for the FE back cards as follows:

```
RPM-3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
RPM-3(config)#
RPM-3(config)# interface fastethernet 2/1
RPM-3(config-if)# full-duplex
Ctrl-z
```

Enter the **show interfaces fastethernet** command to verify that the 2/1 Fast Ethernet interface is now configured for full-duplex operation as follows:

```
RPM-3# sh int fastethernet 2/1
FastEthernet 2/1 is administratively up, line protocol is up
  (display text omitted)
  Encapsulation ARPA, loopback not set, keepalive not set, fdx, 100BaseTX
```

Enter the **no full-duplex** command to return the interface to half-duplex operation as follows:

```
RPM-3# config t
Enter configuration commands, one per line.  End with CNTL/Z.
RPM-3(config)# int fastethernet 2/1
RPM-3(config-if)# no full-duplex
Ctrl-z
RPM-3#
```

Enter the **show interfaces fastethernet** command to verify that the 2/1 Fast Ethernet interface is now configured for half-duplex operation as follows:

```
RPM-3# sh int fastethernet 2/1
FastEthernet2/1 is administratively up, line protocol is up
  (display text omitted)
  Encapsulation ARPA, loopback not set, keepalive not set, hdx, 100BaseTX
  (display text omitted)
```

The RJ-45 receptacle is the default media type for FE-TX back card and the SC receptacle (for fiber-optic connections) is the default media type for FE-FX back card. Use the **media-type mii** command to configure the MII receptacle as the media type for the FE back cards as follows:

```
RPM-3# config t
Enter configuration commands, one per line.  End with CNTL/Z.
RPM-3(config)# int fa 2/1
RPM-3(config-if)# media-type mii
Ctrl-z
RPM-3# sh int fa 2/1
FastEthernet2/1 is administratively up, line protocol is up
  (display text omitted)
  Encapsulation ARPA, loopback not set, keepalive not set, hdx, MII
  (display text omitted)
```

Enter the **media-type 100** command to return the media type for the FE back cards to the RJ-45 receptacle or SC receptacle.

To check the interface configuration using **show** commands, see the section "Configuring 4E and 4E/B Interfaces."

Configuring FDDI Interfaces on the RPM/B

This section provides the procedures for performing a basic configuration of the interfaces on full-duplex FDDI back cards installed in an RPM/B.

Step 1 At the privileged-level prompt, enter configuration mode. Specify that the console terminal will be the source of the configuration subcommands, as follows:

```
RPM-3# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
RPM-3(config)#
```

Step 2 At the prompt, enter the subcommand **interface** to specify the interface to be configured, followed by **fddi** to specify back card type, then *bay/port* (for the bay of the MGX 8850 where the RPM/B resides, upper (1) or lower (2) back card, and for port number on the back card).

In this procedure, the 1 interface of the lower FDDI back card in the RPM in slot 5 of the MGX 8850 is used as an example.

```
RPM-3(config)# interface fddi 2/1
```

Step 3 If IP routing is enabled on the system, you can assign an IP address and subnet mask to the interface with the **ip address** configuration subcommand, as in the following example:

```
RPM-3(config-if)# ip address 1.1.1.10 255.255.255.0
```

Step 4 Add any additional configuration subcommands required to enable routing protocols and set the interface characteristics.

Step 5 Change the shutdown state to up and enable the interface as follows:

```
RPM-3(config-if)# no shutdown
```

Step 6 Configure additional interfaces as required.

Step 7 When you have included all of the configuration subcommands to complete the configuration, press **Ctrl-Z** to exit configuration mode.

Step 8 Write the new configuration to nonvolatile memory as follows:

```
RPM-3# copy running-config startup-config
[OK]
RPM-3#
```

To check the interface configuration using **show** commands, see the section "Configuring FDDI Interfaces on the RPM/B".

Note If you require full-duplex operation, verify that you are using PA-F/FD-SM or PA-F/FD-MM back cards.

Configuring FDDI Full-Duplex Operation

Full-duplex operation requires FDDI back cards PA-F/FD-SM or PA-F/FD-MM.

Full-duplex operation is *not* the default configuration and must be turned on using the **full-duplex** command. To turn off full-duplex operation (and enable half-duplex operation) and reset the interface, use the **no full-duplex** (or **half-duplex**) command.

Following is an example of configuring an FDDI interface for full-duplex operation using the **full-duplex** command:

```
RPM-3# conf t
Enter configuration commands, one per line. End with CNTL/Z.
RPM-3(config)# int fddi 2/1
RPM-3(config-if)# full-duplex
Ctrl-z
RPM-3#
```

Note If the back card does not support full-duplex operation, the following error message will appear: "`%FDDI2/1 interface does not support full-duplex`." If the back card *does* support full-duplex operation, the interface will reset as it changes to full-duplex operation.

The output of the **show interfaces fddi** *bay/port* command displays the state of the FDDI back card interface and the state of full-duplex operation. Following is a partial sample output of this command from an FDDI interface with full-duplex operation enabled:

```
RPM-3# show int fddi 2/1
Fddi 2/1 is up, line protocol is up
 Hardware is MIF68840_MM, address is 0060.7054.8808 (bia 0060.7054.8808)
 Internet address is 2.1.1.3/24
 MTU 4470 bytes, BW 100000 Kbit, DLY 100 usec, rely 255/255, load 9/255
 Encapsulation SNAP, loopback not set, keepalive not set
 ARP type: SNAP, ARP Timeout 04:00:00
  FDX supported, FDX enabled, FDX state is *
```

where *, in the last line, could be *idle*, *request*, *confirm*, or *operation*, depending on the state the FDDI interface was in when the show interfaces command is entered.

When full-duplex operation is turned off using the **no full-duplex** (or **half-duplex**) command, the last line of the preceding display includes the following information: `FDX supported, FDX disabled`. If the back card does *not* support full-duplex, the message `FDX NOT supported` is displayed.

Checking the Configuration

After configuring the new interface, use the **show** commands to display the status of the new interface or all interfaces and the **ping** command to check connectivity.

Using Show Commands to Verify the New Interface Status

The following steps use **show** commands to verify that the new interfaces are configured and operating correctly.

Step 1 Enter the **show version** command to display the system hardware configuration. Ensure that the list includes the new interfaces.

Step 2 Display all the current back cards and their interfaces with the **show controllers** command.

Step 3 Specify one of the new interfaces with the **show interfaces** [*type card/interface*] command. Verify that the first line of the display specifies the interface with the correct slot number. Also verify that the interface and line protocol are in the correct state, up or down.

Step 4 Display the protocols configured for the entire system and specific interfaces with the **show protocols** command. If necessary, return to configuration mode to add or remove protocol routing on the system or specific interfaces.

Step 5 Display the running configuration file with the **show running-config** command.

Step 6 Display the configuration stored in NVRAM using the **show startup-config** command. Verify that the configuration is accurate for the system and each interface.

If the interface is down and you configured it as up, or if the displays indicate that the hardware is not functioning properly, ensure that the network interface is properly connected and terminated. If you have problems bringing the interface up, contact TAC for assistance. For detailed software configuration information, refer to the Cisco IOS configuration and command reference publications. These publications are available on the Documentation CD-ROM that came with your RPM, or you can order printed copies.

Using Show Commands to Display Interface Information

To display information about a specific interface, enter the **show interfaces** command with the interface type and port address in the format **show interfaces** [*type bay/port*] for the MGX 8850 RPM.

Note For complete command descriptions and examples for all of the supported platforms, refer to the publications listed in the Preface.

RPM Show Interfaces Command

Following is an example of how the **show interfaces** [*type bay/port*] command displays status information (including the chassis physical slot, card number,

and port address) for the interfaces you specify. In these examples, the four Ethernet 10BASE-T interfaces (1–4) are in the lower back card in the RPM in slot 4 of the MGX 8850 (interfaces are administratively shut down until you enable them).

```
rpm_slot4#sh int e 2/1
Ethernet2/1 is administratively down, line protocol is down
  Hardware is AmdP2, address is 00c0.0023.84d0 (bia 00c0.0023.84d0)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type:ARPA, ARP Timeout 04:00:00
  Last input never, output never, 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 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
     0 input packets with dribble condition detected
     35 packets output, 5510 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out

rpm_slot4#sh int e 2/2
Ethernet2/2 is up, line protocol is up
  Hardware is AmdP2, address is 00c0.0023.84d1 (bia 00c0.0023.84d1)
  Internet address is 172.29.37.141/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type:ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, 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 0 bits/sec, 1 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     5753 packets input, 399324 bytes, 0 no buffer
     Received 5711 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
     249 packets output, 26248 bytes, 0 underruns
     0 output errors, 1 collisions, 1 interface resets
     0 babbles, 0 late collision, 7 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out

rpm_slot4#sh int e 2/3
Ethernet2/3 is administratively down, line protocol is down
  Hardware is AmdP2, address is 00c0.0023.84d2 (bia 00c0.0023.84d2)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type:ARPA, ARP Timeout 04:00:00
  Last input never, output never, 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 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
     0 input packets with dribble condition detected
     35 packets output, 5510 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out

rpm_slot4#sh int e 2/4
Ethernet2/4 is administratively down, line protocol is down
  Hardware is AmdP2, address is 00c0.0023.84d3 (bia 00c0.0023.84d3)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type:ARPA, ARP Timeout 04:00:00
  Last input never, output never, 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 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
     0 input packets with dribble condition detected
     35 packets output, 5510 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
Switch4/1 is up, line protocol is up
  Hardware is ENHANCED ATM PA
  MTU 4470 bytes, sub MTU 4470, BW 149760 Kbit, DLY 80 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set, keepalive not supported
  Encapsulation(s):AAL5
  4096 maximum active VCs, 0 current VCCs
  VC idle disconnect time:300 seconds
  0 carrier transitions
  Last input never, 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 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     883 packets input, 42644 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
     918 packets output, 44307 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

With the **show interfaces** [*type bay/port*] command, use arguments such as the interface type (ethernet, and so forth), bay and port number (bay/port) to display information about a specific Ethernet 10Base-T interface only.

Viewing the Hardware Configuration

The **show version** (or **show hardware**) command displays the configuration of the system hardware (the number of each back card type installed), the software version, the names and sources of configuration files, and the boot images. Following is an example of the **show version** command:

```
RPM-3# show version

Cisco Internetwork Operating System Software
IOS (tm) RPM Software (RPM-JS-M), Version 12.1(5)T, RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Wed 26-Mar-99 17:14 by marka
Image text-base:0x600088E0, data-base:0x60D74000

ROM:System Bootstrap, Version 11.3(19980311:221233) [phsu-120 237], DEVELOPMENT SOFTWARE
BOOTFLASH:RPM Software (RPM-BOOT-M), Version 12.0(2)T,  RELEASE SOFTWARE (fc1)

rpm_slot4 uptime is 28 minutes
System restarted by reload
Running default software

cisco RPM (NPE150) processor with 57344K/8192K bytes of memory.
```

```
R4700 processor, Implementation 33, Revision 1.0 (512KB Level 2 Cache)
Last reset from power-on
Bridging software.
X.25 software, Version 3.0.0.
SuperLAT software copyright 1990 by Meridian Technology Corp).
TN3270 Emulation software.
4 Ethernet/IEEE 802.3 interface(s)
1 ATM network interface(s)
125K bytes of non-volatile configuration memory.
4096K bytes of packet SRAM memory.

8192K bytes of Flash internal SIMM (Sector size 256K).
Configuration register is 0x2102
```

To determine which type of back card is installed in your system, enter the **show diag** [*slot*] command. Specific back card information is displayed, as shown in the following example of an 4E back card in back card slot 1:

```
RPM-3# show diag 1

Slot 1:
Ethernet port adapter, 4 ports
port adapter is analyzed
port adapter insertion time 2d09h ago
Hardware revision 1.1           Board revision A0
Serial number     4294967295    Part number    73-1556-04
Test history      0x0           RMA number     00-00-00
EEPROM format version 1
EEPROM contents (hex):
0x20: 01 02 01 01 FF FF FF FF 49 06 14 04 00 00 00 00
0x30: 50 00 00 00 FF FF FF FF FF FF FF FF FF FF FF FF
```

See the next section, “Using the ping Command” to verify that each interface port is functioning properly.

Using the ping Command

The *packet internet groper* (**ping**) command allows you to verify that an interface port is functioning properly and to check the path between a specific port and connected devices at various locations on the network. This section provides brief descriptions of the **ping** command. After you verify that the system has booted successfully and is operational, you can use this command to verify the status of interface ports.

The **ping** command sends an echo request out to a remote device at an IP address that you specify. After sending a series of signals, the command waits a specified time for the remote device to echo the signals. Each returned signal is displayed as an exclamation point (!) on the console terminal; each signal that is not returned before the specified time-out is displayed as a period (.). A series of exclamation points (!!!!!) indicates a good connection; a series of periods (.....) or the messages [timed out] or [failed] indicate that the connection failed.

Following is an example of a successful **ping** command to a remote server with the address 1.1.1.10:

```
RPM-3# ping 1.1.1.10 <Return>
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echoes to 1.1.1.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/15/64 ms
RPM-3#
```

If the connection fails, verify that you have the correct IP address for the server and that the server is active (powered on). Repeat the **ping** command.

Configuration Mode

You can configure the RPM manually if you prefer not to use AutoInstall or the prompt-driven System Configuration Dialog.

Note Seen Appendix C, "Cisco IOS Modes of Operation" for basic information about Cisco IOS software, getting context-sensitive help, and saving configuration changes.

Perform the following steps to configure the RPM manually:

Step 1 Connect a console terminal to the RPM.

Follow the instructions described in Chapter 3, "Installing the MGX RPM," in the section "Connecting a Console Terminal or PC to the RPM Console Port," and then power on the RPM.

Step 2 When you are prompted to enter the initial dialog, enter **no** to go into the normal operating mode of the RPM:

```
Would you like to enter the initial dialog? [yes]: no
```

Step 3 After a few seconds you will see the user EXEC prompt (Router>).

By default, the host name is Router, but the prompt will match the current host name. In the following examples, the host name is MGX8850-RPM. Enter the **enable** command to enter enable mode. You can only make configuration changes in enable mode:

```
MGX8850-RPM> enable
```

The prompt will change to the privileged EXEC (enable) prompt, MGX8850-RPM#.

Step 4 Enter the **configure terminal** command at the enable prompt to enter configuration mode:

```
MGX8850-RPM# config terminal
```

You can now enter any changes you want to the configuration. You will probably want to perform the following tasks:

a. Assign a host name for the RPM using the **hostname** command.

b. Enter an enable secret using the **enable secret** command.

c. Enter an enable password using the **enable password** command.

d. Assign addresses to the interfaces using the *protocol* **address** command.

e. Specify which protocols to support on the interfaces.

Refer to the Cisco IOS configuration and command reference publications for more information about the commands you can use to configure the RPM. You can also refer to the *Cisco MGX 8850 Multiservice Switch Installation and Configuration* and *Cisco MGX 8800 Series Switch Command Reference* guides for information about the commands you can use to configure the RPM.

Step 5 When you finish configuring the RPM, enter the **exit** command until you return to the privileged EXEC prompt (MGX8850-RPM#).

Step 6 To save the configuration changes to NVRAM, enter the **copy running-config startup-config** command at the privileged EXEC prompt:

```
MGX8850-RPM# copy running-config startup-config
********
```

The RPM is now configured and will boot with the configuration you entered.

This concludes the initial RPM configuration.

Verifying Network Connectivity

When you have installed and configured the RPM, enter the following commands in user EXEC mode to verify network connectivity.

- **ping**—Sends a special datagram to the destination device, then waits for a reply datagram from that device.
- **telnet**—Logs in to a remote node
- **trace**—Discovers the routes that packets take when traveling from one RPM to another.

If there is a problem with network connectivity, see Appendix A, “Maintaining the MGX RPM” the “Reading Front Panel LEDs” section, and check the cable connections. If there is still a problem, check the RPM configuration. Contact customer service for further assistance.

Specifying the Boot Method

You can enter multiple boot commands in the configuration in NVRAM to provide a backup method for loading the Cisco IOS image onto the RPM. The RPM boots using the first **boot** command that succeeds. If you enter multiple boot commands, the RPM executes them in the order they are entered. There are two ways to load the Cisco IOS image: from the PXM hard drive or from a TFTP server on the network.

1. PXM Hard Drive

   The RPM has access to the file system on the PXM C: drive, in the C:RPM directory. Use the console port on the RPM to boot the RPM from Flash so that you configure its ATM switch interface as **no shutdown**, which lets you access the C: drive on the PXM and copy files to the startup config or to the bootflash.

   Note **no shutdown** is the default.

2. TFTP server

   If the PXM hard drive does not contain a valid Cisco IOS image, you can specify that system software be loaded from a TFTP server on your network as a backup boot method for the RPM. In the following example, replace *filename* with the filename of the Cisco IOS image, and replace *ipaddress* with the IP address of the TFTP server:

```
MGX8850-RPM> enable
Password: enablepassword
MGX8850-RPM# configure terminal
MGX8850-RPM (config)# boot system tftp filename ipaddress
MGX8850-RPM (config)# Ctrl-Z
```

```
MGX8850-RPM# copy running-config startup-config
Building configuration ...
[OK]
MGX8850-RPM# exit
MGX8850-RPM>
```

In the following example, replace filename with the filename of the Cisco IOS image. Type the following commands to boot the RPM from the PXM and copy files:

```
MGX8850-RPM> enable
Password:enablepassword
MGX8850-RPM# configure terminal
MGX8850-RPM (config)# boot system c:filename
MGX8850-RPM (config)# Ctrl-Z
MGX8850-RPM# copy running-config startup-config
Building configuration ...
[OK]
MGX8850-RPM#

*****
```

Then reload the RPM to get back to rommon and then boot full IOS from the PXM disk.

Note Put the RPM IOS image in the RPM directory of the PXM hard disk with the filename specified in the RPM boot command.

Configuring Permanent Virtual Circuits on the RPM

A PVC is a point-to-point connection between two or more devices. This section describes how to configure a PVC originating on the RPM ATM interface and terminating on a service module within a single MGX 8850 or on another RPM.

A PVC is established for each ATM end node with which the RPM communicates. The characteristics of the PVC are established when the PVC is created and include the following:

- Quality of service (QoS)
- ATM Adaptation Layer 5 mode (AAL5)
- Encapsulation type (LLC/SNAP, MUX, and QSAAL)

Each RPM PVC supports routing protocols including the following:

- Mulitprotocol IP: static route, IGRP, RIPv1 & v2, OSPF, IS-IS, EIGRP, BGP with multiprotocol extensions.

  In most service provider network cores, the recommended routing protocols are OSPF or IS-IS, with additional use of BGP where appropriate.
- Multiprotocol Label Switching (MPLS)

  Note MPLS encapsulation within a PVC is only one of two MPLS modes supported by the RPM. The other is full ATM MPLS which uses MPLS Label VCs (LVCs) and not PVCS.
- Fast switching of IP packets
- Pseudobroadcast support for multicast packets

Resource Partitioning

Like the other card modules in the MGX 8850 switch, resource partitions must be defined on the RPM. The **rpmrscprtn** command defines the bandwidth and addressing resources assigned to each controller (PAR, Tag (MPLS), or PNNI).

The **rpmrscprtn** command is used to modify the resource partitioning on the RPM. It is necessary to use the **rpmrscprtn** command before you add any PVCs or connections to the RPM because by default all partitions are disabled. Enter the **rpmrscprtn** command to set up resource partitioning, as shown in the following example:

```
RPM-3(config)# rpmrscprtn PAR 100 100 1 255 0 3840 4047
Partition type [par|tag|pnni] Percent ingress [<0-100>] Percent egress [<0-100>] Minimum
VPI [<0-255>] Maximum VPI [<0-255> Minimum VCI [<0-3840>] Maximum VCI [<0-3840>] Number of
LCNs [<0-4047>]
```

Note The MGX 8850 CLI has partitioning capability to support MPLS or “Tag” control of the MGX resources. The “Tag” partition will be required once the MGX 8850 has support for an RPM acting as a Label Switch Controller (LSC). LSC support is not yet available, so the “Tag” partition is not used. Despite the lack of a “Tag” partition, the MGX 8850supports MPLS edge function, by use of either PVCs or PVPs. For more information, see Chapter 7, “Configuring MPLS and VPN.”

Table 5-1 describes the **rpmrscprtn** command parameters.

Table 5-1 rpmrscprtn Parameter Description

Parameter	Description
par | tag | pnni	The controller type that you want to define.
ingress-percent	The percentage of the ingress bandwidth on the ATM switch interface that can be allocated by the controller type. The aggregate of the ingress bandwidth across all three controllers can exceed 100 percent.
egress-percent	The percentage of the egress bandwidth on the ATM switch interface that can be allocated by the controller type. The aggregate of the egress bandwidth across all three controllers can exceed 100 percent.
min-vpi	The minimum VPI value that can be assigned on PVCs on this controller. The VPI range on the three controllers can overlap.
max-vpi	The maximum VPI value that can be assigned on PVCs on this controller. The VPI range on the three controllers can overlap.
min-vci	The minimum VCI value that can be assigned on PVCs on this controller. Unlike the VPI range, the VCI range cannot overlap the VCI range of another controller.
max-vci	The maximum VCI value that can be assigned on PVCs on this controller. Unlike the VPI range, the VCI range cannot overlap the VCI range of another controller.
lcns	The total number of logical connections that can use this controller.

Configuring Permanent Virtual Circuits

All permanent virtual circuits (PVCs) configured into the RPM remain active until the circuit is removed from the configuration. The PVCs also require a permanent connection to the ATM switch. All virtual circuit characteristics apply to PVCs. When a PVC is configured, all the configuration options are passed on to the ATM port adapter. These PVCs are writable into nonvolatile RAM (NVRAM) as part of the RPM configuration and are used when the RPM image is reloaded.

Each PVC on the RPM is associated with a subinterface. Some subinterfaces support multiple PVCs (multipoint) that do the equivalent of broadcasting. Others only support one PVC (point-to-point). If a point-to-multipoint PVC exists, then that PVC can be used as the sole broadcast PVC for all multicast requests.

Each subinterface is identified as *slot/interface.subinterface*. The *slot* is the card slot number of the RPM, the *interface* is always 1, and the *subinterface* is a number that identifies the subinterface PVCs on the RPM.

A subinterface is created while in the configuration mode by typing the **interface switch** command. The **IP address** is set using the IP address command.

To configure a PVC, you must perform the following tasks:

Step 1 Create a point-to-point or multipoint subinterface.

Step 2 Assign an IP address to the subinterface.

Step 3 Create an ATM PVC.

Step 4 Define a map list (for multipoint only).

Step 5 Add a connection between the RPM and the PXM.

Step 6 Add the remaining connection segments as needed.

Refer to the *MGX 8850 Wide Area Switch Installation and Configuration*, for more information on creating PVCs on the RPM and the rest of the Cisco 7000 family of routers. See Chapter 6, “Setting Up Connections Between Other Devices and the RPM.”

Creating a PVC

When you create a PVC, you create a virtual circuit descriptor (VCD) and attach it to the virtual path identifier (VPI) and virtual channel identifier (VCI). A VCD is an ATM port adapter-specific mechanism that identifies to the ATM port adapter which VPI/VCI to use for a particular packet. The ATM port adapter requires this feature to manage packets for transmission. The number chosen for the VCD is independent of the VPI/VCI used. When you create a PVC, you also specify the AAL and encapsulation. A rate queue is used that matches the default peak and average rate, which are equal, and are specified in kilobits per second. To create a PVC on the ATM port adapter interface, use the **atm pvc** command. To remove a PVC, enter the **no** form of this command.

```
atm pvc vcd vpi vci aal-encap
no atm pvc vcd

RPM:
RPM-3(config)# interface switch chassis-slot/1.subinterface interface-type
```

where the interface-type is either point-to-point, multipoint, or tag.

```
RPM-3(config-if)# atm pvc 2048 255 128 aal5snap
```

Note You can also use the **pvc vpi/vci** command, which is described in the Cisco IOS documentation.

Note Because the ATM port adapter is internal to the RPM and the interface is logical not physical, you can not remove it. It is always referred to as *slot/1*.

- **vcd**—A unique index value describing this VC in the range of 1 to MAXVC (defined when setting up resource partitioning). Do not use VCD 1, as this is reserved to the system.
- **vpi**—The ATM network VPI to use for this VC in the range of 0 through 255. A VPI of 0 indicates that this PVC is a VCC. A non-0 value indicates that the PVC is a VPC.
- **vci**—The ATM network VCI to use for this VC in the range of 0 through 3,824.
- **aal-encap**—The encapsulation type to use on this VC from the following:
  - **aal5mux**—Specifies the MUX-type for this VC. A protocol type must be specified.
  - **aal5snap**—LLC/SNAP precedes the protocol datagram.
  - **aal5nlpid**—NLPID precedes the protocol datagram.
  - **qsaal**—A signaling type VC.
  - **aal5ciscoppp**—Used for PPP applications.

The **atm pvc** command creates *PVC n* and attaches the PVC to *VPI* and *VCI*. The AAL used is specified by *aal* and encapsulation by *encap*.

The default for peak rate and average rate is that peak = average, and the PVC is automatically connected to the highest bandwidth rate queue available. For detailed software configuration information, refer to the Cisco IOS configuration and command reference publications. These publications are available on the Documentation CD-ROM that came with your RPM, or you can order printed copies.

Mapping a Protocol Address to a PVC

Cisco IOS software supports a mapping scheme that identifies the ATM address of remote hosts/RPMs. This address can be specified either as a VCD for a PVC or a network service access point (NSAP) address for SVC operation.

Enter mapping commands as groups; multiple map entries can exist in one map list. First create a map list, then associate the list with an interface.

Enter the **map-list** command and then enter the protocol, protocol address, and other variables, as follows:

```
map-list name
protocol-type protocol-address [atm-vc vcd] | atm-nsap nsap-address] [broadcast]
```

The **broadcast** keyword specifies that this map entry receives the corresponding protocol broadcast requests to the interface (for example, any network routing protocol updates). If you do not specify **broadcast**, the ATM software is prevented from sending routing protocol updates to the remote hosts.

After you create the map list, specify the ATM interface to which it applies with the interface command, as follows:

RPM usage:

```
RPM-3# interface switch 5/1
```

Associate the map list to an interface with the following command:

map-group *name*

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. The following is an example of the commands to map a list to an interface on an RPM:

```
RPM-3# interface switch 5/1
ip address 1.1.1.2 255.255.255.0
 map-group atm1
 atm pvc 2 0 1 aal5snap
!
no ip classless
!
map-list atm1
 ip 1.1.1.1 atm-vc 2 broadcast
```

Note The RPM can not use VCD=1, because it already uses VCD=1 for the IP connection to the PXM.

Establishing 1:N Redundancy Between Two or More RPM Cards

RPM cards support 1:N redundancy, whereby one RPM card can be configured as a redundant or secondary (backup) card for one or multiple primary RPM cards, forming a redundant group. There can be multiple redundant groups in one shelf. RPM 1:N redundancy is a cold redundancy, in which the configuration of a failed primary card is copied to the standby secondary card. All traffic to and from the primary RPM card is switched to the secondary card after it becomes active. Because this is a cold redundancy solution, service interruption is expected. As with other service modules, the layer 2 state is restored when the secondary card becomes active. However, RPM also performs layer 3 functionality, such as maintaining routing tables. The routing tables are created manually or by routing protocols, such as IGRP, BGP, or OSPF. Because routing protocols are used, the layer 3 state is restored within three to five minutes, depending on the protocol used.

RPM 1:N redundancy supports the following features:

- Increases availability by decreasing the DPM of the network by reducing boot-up, switchover, and upgraded times.
- Supports L2 redundancy and restores L3 state via reconvergence.
- Supports RPM 1:1 warm redundancy when N=1.
- Support for up to 11 active (primary) RPM cards per single redundant (standby or secondary) RPM for the MGX 8850 and MGX 8250.
  Support for up to 3 active (primary) RPM cards per single redundant (standby or secondary) RPM for the MGX 8230.
- Support for a maximum of 6 redundant groups per MGX 8850 or MGX 8250.
  Support for a maximum of 2 redundant groups per MGX 8230..
- Does not utilize either the MGX 8850 distribution or redundancy bus.

The redundant card must be present and active and must not have any connections configured. Any connection configuration will cause the **addred** command to be rejected.

Note Secondary or redundant cards can only backup like RPM cards. Therefore, secondary or standby RPM/B cards can only backup primary RPM/B cards, and secondary RPM-PR cards can only backup primary RPM-PR cards.

To establish a backup card for an RPM card, use the following procedure.

Step 1 Establish a configuration session using a user name with SUPER_GP privileges or higher.

Step 2 If you have not done so already, initialize both cards as described earlier in this chapter.

Step 3 Enter the **dspcds** command to verify that the primary and secondary RPM card are in the "Active" state.

Step 4 Enter the **addred** command.

```
pop20one.7.PXM.a > addred <redPrimarySlotNum> <redSecondarySlotNum> <redType>
```

where *<redPrimarySlotNum>* is the slot number of the primary RPM card, *<redSecondarySlotNum>* is the slot number of the secondary RPM card, and *<redType>* is the number 2 for 1:*n* redundancy.

After you enter the **addred** command, the switch resets the secondary card; therefore, the secondary card will be unavailable for a few minutes. When the reset is complete, enter the **dspcds** command to show the primary and secondary cards in the active and standby states, respectively.

The redundant RPM cards are shown in slots 2 and 9 with the standby card in slot 9.

```
Unknown.7.PXM.a > dspcds
Unknown                          System Rev: 02.01   Mar. 19, 2001 23:14:58 GMT
Chassis Serial No:   SAA03230404 Chassis Rev: B0     GMT Offset: 0
                                                     Node Alarm: MAJOR
Card  Front/Back          Card           Alarm      Redundant   Redundancy
Slot  Card State          Type           Status     Slot        Type
---   ----------          --------       --------   -------     -----

01    Empty               ---            ---        ---         ---
02    Active/Empty        RPM            NONE       09          PRIMARY SLOT
03    Empty               ---            ---        ---         ---
04    Empty               ---            ---        ---         ---
05    Empty               ---            ---        ---         ---
06    Active/Empty        AXSM_1OC48     NONE       NA          NO REDUNDANCY
07    Active/Active       PXM            NONE       08          PRIMARY SLOT
08    Empty Resvd/Empty   ---            MAJOR      07          SECONDARY SLOT
09    Standby/Empty       RPM            NONE       09          SECONDARY SLOT
10    Empty               ---            ---        ---         ---
11    Empty               ---            ---        ---         ---
12    Empty               ---            ---        ---         ---
13    Empty               ---            ---        ---         ---
14    Empty               ---            ---        ---         ---
```

Step 5 To display the redundancy relationship between all cards in the switch, enter the **dspred** command.

Redundant cards are displayed as shown below, indicating primary and secondary slot numbers, card types, card states, and redundancy type.

```
Unknown.7.PXM.a > dspred
Unknown                          System Rev: 02.01   Mar. 19, 2001 23:15:37 GMT
MGX8850                                              Node Alarm: MAJOR
Primary  Primary   Primary    Secondary  Secondary  Secondary    Redundancy
SlotNum   Type      State      SlotNum     Type       State         Type
-------  -------  ---------   ---------  ---------  ---------    ----------
  2      RPM       Active        9        RPM        Standby       1-n

  7      PXM       Active        8        PXM        Empty Resvd    1-1
```

Step 6 Return to the primary RPM by entering the **cc** command, **cc** <*redPrimarySlotNum*>.

```
Unknown.7.PXM.a > cc 2
```

Step 7 Enter **Copy Run Start** or **Write Mem** to save the configuration to the PXM-1 hard disk C:RPM directory.

This file will be used as the configuration file. The name of the file is **auto_config_slot#** where **#** is the primary slot number.

Using Softswitch to Change the Active Card

Enter the **softswitch** command to manually change the active card to the standby card. You may want to do this if you need to remove the original active card from the MGX8850 shelf. Before you begin this procedure, make sure that the destination card is in Standby mode. To change the active cards, follow the steps below.

Step 1 Enter the **softswitch** command.

```
Unknown.7.PXM.a > softswitch 2 9
softswitch: Do you want to proceed (Yes/No)? y

where 2 is the active card and 9 is the destination card.
```

The card in slot 9 is now the active RPM card, and the RPM card in slot 2 is reset. It comes up in standby mode after a couple of minutes.

The new active card will not revert to standby mode automatically. Enter **softswitch** to manually switch over the active card back to standby mode. This is the only way the active card will switch over to standby, unless the active card fails.

Step 2 Enter the **softswitch** command to switch the active card back to the original RPM.

```
Unknown.7.PXM.a > softswitch 9 2
softswitch: Do you want to proceed (Yes/No)? y
where 9 is the active card and 2 is the destination card.
```

Deleting Redundancy

To delete card redundancy, the primary card must be active, otherwise this command will be rejected. Enter **delred** followed by the primary card's slot number, as shown here:

```
Unknown.7.PXM.a > delred 2
Redundancy link is deleted
```

The secondary card is reset and comes back up as an active normal RPM card (if it is the last primary card) that can be used for any other purpose. In the following example, the card in slot 9 is now active.

```
Unknown.7.PXM.a > dspcds
Unknown                          System Rev: 02.01   Mar. 20, 2001 00:00:01 GMT
Chassis Serial No:   SAA03230404 Chassis Rev: B0     GMT Offset: 0
                                                     Node Alarm: MAJOR
Card  Front/Back          Card           Alarm      Redundant   Redundancy
Slot  Card State          Type           Status     Slot        Type
---   ----------          --------       --------   -------     -----
```

```
01    Empty               ---            ---        ---         ---
02    Active/Empty        RPM            NONE       NA          NO REDUNDANCY
03    Empty               ---            ---        ---         ---
04    Empty               ---            ---        ---         ---
05    Empty               ---            ---        ---         ---
06    Active/Empty        AXSM_1OC48     NONE       NA          NO REDUNDANCY
07    Active/Active       PXM1           NONE       08          PRIMARY SLOT
08    Empty Resvd/Empty   ---            MAJOR      07          SECONDARY SLOT
09    Active/Empty        RPM            NONE       NA          NO REDUNDANCY
10    Empty               ---            ---        ---         ---
11    Empty               ---            ---        ---         ---
12    Empty               ---            ---        ---         ---
13    Empty               ---            ---        ---         ---
14    Empty               ---            ---        ---         ---

Unknown.7.PXM.a >
```

Adding Additional Primary Cards

You can add one or more additional RPM cards as primary cards backed up by the secondary card. To do this, enter the **addred** command with the additional card slot numbers.

```
switch.7.PXM.a > addred <redPrimarySlotNum> <redSecondarySlotNum> <redType>
```

Repeat this step for each additional card you want to add to the secondary card backup protection.

Upgrading with 1:N Redundancy

The following procedure describes how to upgrade redundant RPM cards.

Note Redundancy must be established before you use this procedure.

Step 1 On the primary RPM card, upgrade the software. Refer to the *1.1.40 Version Software Release Notes Cisco WAN MGX 8850, MGX 8230, and MGX 8250 Switches.*

Tips Enter the **copy run start** command to save the configuration change.

Step 2 Switch to the secondary card using the **softswitch** command.

```
mgx8850a.7.PXM.a > softswitch <fromSlot> <toSlot>
```

This step makes the secondary card active and resets the primary RPM card. When the primary card resets, it loads the upgraded software defined in Step 1.

Step 3 After the secondary card is active, configure it to upgrade the software. (See Step 1.)

Step 4 Switch back to the primary card using the **softswitch** command.

This step makes the upgraded primary card active and resets the secondary card. When the reset is complete, the secondary card runs the upgraded software.

Step 5 If there are other primary cards with redundant (secondary) cards, repeat this procedure for each primary card.

Setting Up Connections Between Other Devices and the RPM

This chapter describes how to make connections between an RPM and a PXM and among either service modules or other RPMs. The chapter contains the following sections:

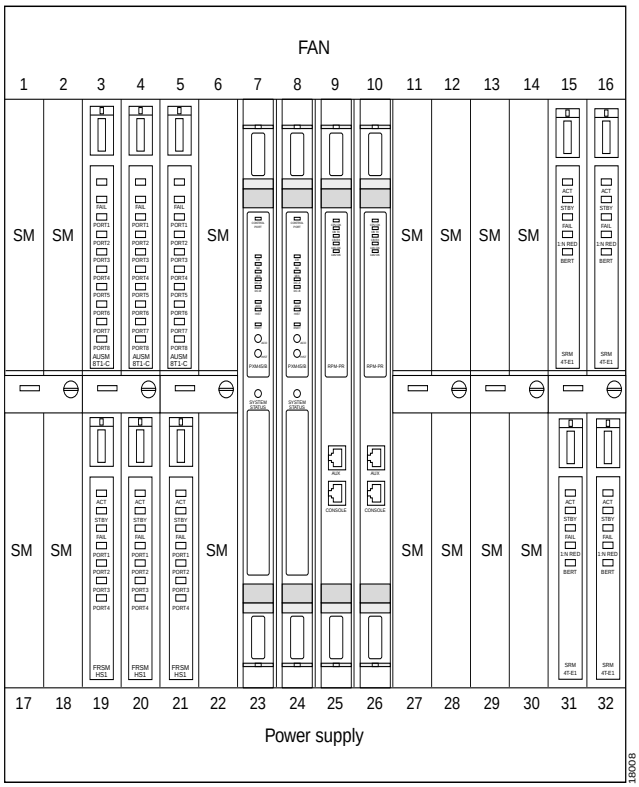
- Configuring Connections Between the RPM and Other Devices
- Setting Up Connections Between CWM and the RPM
- Setting Up Connections Between Service Modules and the RPM
- ATM Configuration Examples
- Fully Meshed ATM Configuration Example
- RPM-to-Service Module DAX Connections
- RPM-to-PXM Feeder Trunk Connections
- Connection Synchronization
- Connection State Alarms

Configuring Connections Between the RPM and Other Devices

After configuring port adapters on the RPM, the user's next step is to configure connections between the RPM and other devices (service modules, other RPMs) via the PXM.

The PXM (the main processor on the MGX 8850) coordinates all communication between the RPM and service modules and other RPMs. See Figure 6-1 for a view of how service modules fit in the MGX 8850.

Figure 6-1 Service Modules in the MGX 8850



A complete connection between the RPM and any of these devices includes two parts:

- Half between the RPM and the PXM.
- Half between the PXM and the service module or a different RPM.

Setting Up the RPM Connection to the PXM

First, set up the connection between the RPM and the PXM.

For the RPM in slot 9 connecting to slot 6, perform the following procedure:

Step 1 Set up a logical interface:

```
RPM-3(config)# int sw 5/1.1 point-to-point
ip address 1.0.0.1 255.0.0.0
```

Step 2 Set up pvc:

```
RPM-3(config-if)# atm pvc 2 0 1 aal5snap
```

Step 3 To return to the global level, type **exit**:

```
RPM-3(config-if)# exit
RPM-3(config)#
```

Step 4 Enter the **rpmrscprtn** command to set up resource partitioning

```
RPM-3(config)# rpmrscprtn PAR 100 100 1 255 0 3840 4080
```

Partition type [par|tag|pnni] *Percent ingress* [*<0-100>*] *Percent egress* [*<0-100>*] *Minimum VPI* [*<0-255>*] *Maximum VPI* [*<0-255> Minimum VCI* [*<0-3840>*] *Maximum VCI* [*<0-3840>*] *Number of LCNs* [*<0-4080>*]

Step 5 Add a connection to the PVC—either VCC (virtual circuit connection) or VPC (virtual path connection):

```
RPM-3(config)# addcon vcc Switch slot/1[.sub-interface] vci [rname rname] rslot rslot
r_int r_vpi r_vci [master {local | remote}]
```

or

```
RPM-3(config)# addcon vpc Switch slot/1[.sub-interface] vpi [rname rname] rslot rslot
r_int r_vpi [master {local | remote}]
```

Available Parameters

The following parameters are available to set up the RPM to PXM connection.

- **slot**—RPM slot number
- **sub-interface**—Optional sub-interface
- **vci**—Local VCI
- **vpi**—Local VPI
- **rname**—Remote nodename
- **rslot**—Remote slot
- **r_int**—Remote interface, for example, Switch interface number, or SM port number
- **r_vpi**— Remote VPI
- **r_vci** —Remote VCI
- **master**
  - Local makes this RPM the master end of the connection. Type **master local** to make the local RPM you are configuring master.

    Use **master local** for connections to the PXM or to other SMs, or when connecting to FRSM, PXM for 2- or 3-segment connections. In a local (DAX) RPM-RPM connection, one side must be **master**.
  - Remote (default) makes the other RPM the master end of the connection. Type **master remote** or press **Enter** to make the far-end RPM master.
- **cost**—Maximum connection cost, <1-255> (default 255)
- **priority**—Routing priority, <0-15> (default 0)
  - none—No restriction (default)
  - satellite—Avoid satellite trunks
  - terrestrial—Avoid terrestrial trunks
- **restriction**—Restricted Trunk Type
  - none—No restriction (default)
  - satellite—Avoid satellite trunks
  - terrestrial—Avoid terrestrial trunks

- **rmcr**—Remote MCR value, <0-353208> (default 0; allowed rmcr range will be either <0-rpcr> or <0-0> if rpcr is not explicitly configured)
- **rpcr**—Remote PCR value, <0-353208> (default 353208)
- **rutil**—Remote percent utilization, <0-100> (default 100)
- **util**—Connection percent utilization value, <0-100> (default 100)

Example RPM-PXM Configuration

The following example displays a configuration linking the RPM to the PXM module.

```
popeye01.1.7.PXM.a > cc
(session redirected)

RPM configuration

User Access Verification
Password: (cisco)

rpm01>ena
Password: (cisco)
rpm01#conf t
Enter configuration commands, one per line. End with CNTL/Z.

rpm01(config)#int ?

    ATM                   ATM interface
    Async                 Async interface
    BVI                   Bridge-Group Virtual Interface
    Cable                 CMTS interface
    Dialer                Dialer interface
    Ethernet              IEEE 802.3
    FastEthernet          FastEthernet IEEE 802.3
    Group-Async           Async Group interface
    Lex                   Lex interface
    Loopback              Loopback interface
    Null                  Null interface
    Port-channel          Ethernet Channel of interfaces
    Switch                Switch Virtual Interface
    Tunnel                Tunnel interface
    Virtual-Template      Virtual Template interface
    Virtual-TokenRing     Virtual TokenRing

rpm01(config)#int sw ?

    <1-16>         Chassis slot number

rpm01(config)#int sw 9/?

    <0-1>          Switch interface number

rpm01(config)#int sw 9/1?

    .              <0-1>

rpm01(config)#int sw 9/1.66 ?

    multipoint             Treat as a multipoint link
    point-to-point         Treat as a point-to-point link
    tag-switching          Treat as a tag switching link
    <cr>
```

```
rpm01(config)#int sw 9/1.66 point

rpm01(config-subif)#ip ?

Interface IP configuration subcommands:
    access-group           Specify access control for packets
    accounting             Enable IP accounting on this interface
    address                Set the IP address of an interface
    authentication         authentication subcommands
    bandwidth-percent      Set EIGRP bandwidth limit
    broadcast-address      Set the broadcast address of an interface
    cgmp                   Enable/disable CGMP
    directed-broadcast     Enable forwarding of directed broadcasts
    dvmrp                  DVMRP interface commands
    hello-interval         Configures IP-EIGRP hello interval
    helper-address         Specify a destination address for UDP broadcasts
    hold-time              Configures IP-EIGRP hold time
    igmp                   IGMP interface commands
    irdp                   ICMP Router Discovery Protocol
    load-sharing           Style of load sharing
    mask-reply             Enable sending ICMP Mask Reply messages
    mroute-cache           Enable switching cache for incoming multicast packets
    mtu                    Set IP Maximum Transmission Unit
    multicast              IP multicast interface commands
    nat                    NAT interface commands
    nhrp                   NHRP interface subcommands

rpm01(config-subif)#ip address 6.6.6.6 255.255.255.0

rpm01(config-subif)#atm ?

    address-registration      Address Registration
    arp-server                Configure IP ARP Server
    auto-configuration        ATM interface auto configuration
    classic-ip-extensions     Specify the type of Classic IP extensions
    e164                      E164 Configuration
    esi-address               7-octet ATM ESI address
    ilmi-enable               ILMI Configuration
    ilmi-keepalive            Keepalive polling configuration
    lecs-address              LECS Address
    multipoint-signaling     Multipoint Signaling
    nsap-address              20-octet ATM NSAP address
    pvc                       Create a PVC
    signaling                Signaling subcommands

rpm01(config-subif)#atm pvc ?

    <1-4095>         VCD number

rpm01(config-subif)#atm pvc 66 ?

    <0-255>          VPI number

rpm01(config-subif)#atm pvc 66 0 ?

    <1-65535>        VCI number

rpm01(config-subif)#atm pvc 66 0 66 ?

    aal5ciscoppp     Cisco PPP over AAL5 Encapsulation
    aal5mux          AAL5+MUX Encapsulation
    aal5nlpid        AAL5+NLPID Encapsulation
    aal5snap         AAL5+LLC/SNAP Encapsulation
```

```
rpm01(config-subif)#atm pvc 66 0 66 aal5snap ?

    <1-155000>       Peak rate(Kbps)
    inarp            Inverse ARP enable
    oam              OAM loopback enable
    <cr>

rpm01(config-subif)#atm pvc 66 0 66 aal5snap

rpm01(config-subif)#exit

rpm01(config)#rpmrscprtn ?

    par              Partition for PAR
    pnni             Partition for PNNI
    tag              Partition for TAG

rpm01(config)#rpmrscprtn par ?

    <0-100>          Ingress Percent Bandwidth

rpm01(config)#rpmrscprtn par 100 ?

    <0-100>          Egress Percent Bandwidth

rpm01(config)#rpmrscprtn par 100 100 ?

    <0-255>          Minimum VPI Value

rpm01(config)#rpmrscprtn par 100 100 0 ?

    <0-255>          Maximum VPI Value

rpm01(config)#rpmrscprtn par 100 100 0 255 ?

    <0-3840>         Minimum VCI Value

rpm01(config)#rpmrscprtn par 100 100 0 255 0 ?

    <0-3840>         Maximum VCI Value

rpm01(config)#rpmrscprtn par 100 100 0 255 0 3840 ?

    <0-4080>         Number of LCNs

rpm01(config)#rpmrscprtn par 100 100 0 255 0 3840 4080

rpm01(config)#addcon ?

    vcc              Add a vcc connection
    vpc              Add a vpc connection

rpm01(config)#addcon vcc ?

    Switch           Switch Virtual Interface

rpm01(config)#addcon vcc sw ?

    <1-16>           Chassis slot number

rpm01(config)#addcon vcc sw 9/?

    <0-1>            Switch interface number
```

```
rpm01(config)#addcon vcc sw 9/1?

    <0-1>            Switch sub-interface number

rpm01(config)#addcon vcc sw 9/1.66 ?

    <1-3824>         local VCI value

rpm01(config)#addcon vcc sw 9/1.66 66 ?

    rname            remote node name
    rslot            Remote slot number

rpm01(config)#addcon vcc sw 9/1.66 66 rslot ?

    <0-30>           Remote slot number

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 ?

    <0-512>          Remote interface

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 ?

    <0-255>          Remote VPI

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 0 ?

    <0-65535>        Remote VCI

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 0 66 ?

    cost             Maximum connection cost
    master           Master end of the ATM connection
    priority         Routing priority
    restriction      Restricted Trunk Type
    rmcr             Connection Remote MCR
    rpcr             Connection Remote PCR
    rutil            Connection Remote percent utilization
    util             Connection precent utilization
    <cr>

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 0 66 master ?

    local            Local option
    remote           Remote option

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 0 66 master local ?

    cost             Maximum connection cost
    priority         Routing priority
    restriction      Restricted Trunk Type
    rmcr             Connection Remote MCR
    rpcr             Connection Remote PCR
    rutil            Connection Remote percent utilization
    util             Connection precent utilization
    <cr>

rpm01(config)#addcon vcc sw 9/1.66 66 rslot 0 1 0 66 master local
```

Note The above example adds a connection to the active PXM.
The RPM is the MASTER and not the slave.
SlotNo = 0 (zero) which points to the active PXM.

```
rpm01(config)#exit
rpm01#wr mem

Building configuration...

rpm01#wr t

Building configuration...
Current configuration:

!
version 12.0
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname rpm01
!
boot system c:rpm-js-mz.120-2.5.T
enable password cisco
!
ip subnet-zero
!
!
!
interface FastEthernet1/1
no ip address
no ip directed-broadcast
shutdown
!
interface Ethernet2/1
no ip address
no ip directed-broadcast
shutdown
!
.
.
!
interface Ethernet2/4
no ip address
no ip directed-broadcast
shutdown
!
interface Switch9/1
no ip address
no ip directed-broadcast
!
!
interface Switch9/1.66 point-to-point
ip address 6.6.6.6 255.255.255.0
no ip directed-broadcast
atm pvc 66 0 66 aal5snap
!
!
ip classless
```

```
!
!
!
line con 0
transport input none
line aux 0
line vty 0 4
password cisco
login
!
rpmrscprtn PAR 100 100 0 255 0 3840 4080
addcon vcc switch 9/1.66 66 rslot 0 1 0 66 master local
end

rpm01#cc 7
(session redirected)


PXM configuration

popeye01.1.7.PXM.a > dspcons (connection added is shown in blue)

dspcons

This End        Node Name     Other End     Status

1.1.0.0         popeye01      7.1.10.100    OK
2.1.0.100       popeye01      7.1.0.100     OK
3.1.20.200      popeye01      7.1.20.200    OK
7.1.0.100       popeye01      2.1.0.100     OK
7.1.10.100      popeye01      1.1.0.0       OK
7.1.20.200      popeye01      3.1.20.200    OK
7.1.0.66        popeye01      9.1.0.66      OK
9.1.0.66        popeye01      7.1.0.66      OK

popeye01.1.7.PXM.a > addcon

addcon

ERR: incorrect number of parameters: (not enough)
Syntax:     addcon "port_no conn_type local_VPI local_VCI service [mastership]
                [remoteConnId]"
            port_no -- a number 1..32
            conn_type -- a number 1..2 (1: vpc 2: vcc)
            local_VPI -- a number 0..4095
            local_VCI -- a number 0..65535
            service -- a number 1..4 (1:cbr 2:vbr 3:abr 4:ubr)
            mastership -- a number 1..2 (1:master 2:slave default:2)
            remoteConnId -- a string (format: NodeName.SlotNo.PortNo.VPI.VCI),
                required if mastership is 1 (master)

popeye01.1.7.PXM.a > addcon 1 2 0 66 1 2 popeye01.9.1.0.66

addcon 1 2 0 66 1 2 popeye01.9.1.0.66
Connection ID: popeye01.0.1.0.66
```

Note The above example completes the RPM connection.
The PXM is NOT the master but the slave.

Setting Up Connections Between CWM and the RPM

In an MGX 8850 standalone application, you need to set up and configure connections between the Cisco WAN Manager (CWM) and the RPM in order to access and configure the PXM module through the RPM. Do this by adding a connection to the 7.34 port on the PXM.

On the RPM Side

Use the following configuration procedure on the RPM side to set up this connection.

Step 1 Add a sub-interface and provide an IP address and a VPI/VCI.

Step 2 Enter the **addcon** command to add a connection to the 7.34 port on the PXM and configure this connection as Master.

Note This is the only place that the remote slot number is designated as 7 for PXM.

Step 3 Verify the connection by entering the **show switch connection** command**.** The connection should be in sync.

Step 4 Add a static route for the ATM IP address of the PXM pointing to the sub-interface that was added above in Step 1.

Step 5 Verify that the static route exists in the RPM by entering the **show ip route** command.

On the PXM Side

Use the following configuration procedure on the PXM side to set up this connection.

Step 1 Configure an ATM IP address using the **cnfifip** command.

Step 2 Verify that the connection added from the RPM is available in the PXM by entering the **dspcons** command.

Note The LAN IP and IP relay address need to be on different networks.

The connection should be in OK state.

Step 3 Verify that the PXM ATM IP address is accessible from RPM by using the **ping** command.

Step 4 Add a route on the CWM to the PXM ATM IP address pointing to the RPM Ethernet IP address.

Step 5 **ping** the PXM ATM IP address from CWM.

You should now be able to access the MGX 8850, MGX 8250, or MGX 8230 shelf from CWM via the RPM.

Sample CWM-PXM Configuration

Here is a sample configuration linking the CWM with the PXM through the RPM module.

On the RPM Side

The following screen capture displays how the connection looks from the RPM.

```
interface Switch1.1 point-to-point
ip address 11.11.11.1 255.255.255.252
no ip route-cache
no ip mroute-cache
pvc 0/10
encapsulation aal5snap
!
ip route 0.0.0.0 0.0.0.0 Ethernet1/1
ip route 172.1.1.0 255.255.255.0 Switch1.1                  <---- Important
!
rpmrscprtn PAR 100 100 0 255 0 3840 4080
addcon auto_synch off
addcon vcc switch 1.1 10 rslot 7 34 0 34 master local

Show commands

netboot-rpm2#show switch connections

Synch
1Vpi   lVci     remoteNodeName   remoteSlot remoteIf  rVpi   rVci  Status

 0      10                        7          34        0      34   inSynch

netboot-rpm2#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 0.0.0.0 to network 0.0.0.0

172.1.0.0/24 is subnetted, 1 subnets
S       172.1.1.0 is directly connected, Switch1.1
172.29.0.0/24 is subnetted, 1 subnets
C       172.29.37.0 is directly connected, Ethernet1/1
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
S       10.10.10.2/32 is directly connected, Switch1.1
C       10.10.10.0/24 is directly connected, Loopback0
11.0.0.0/30 is subnetted, 1 subnets
C       11.11.11.0 is directly connected, Switch1.1
S*   0.0.0.0/0 is directly connected, Ethernet1/1
netboot-rpm2#

Verification of PXM ATM/ip address access from RPM

netboot-rpm2#ping 172.1.1.201

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.1.1.201, timeout is 2 seconds:
!!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
netboot-rpm2#
```

On the PXM Side

The following screen capture displays how the connection looks from the PXM.

```
mgx2.1.7.PXM.a > dspifip
Interface        Flag  IP Address       Subnetmask       Broadcast Addr
--------------  ----  ---------------  ---------------   ---------------
Ethernet/lnPci0  UP    172.29.37.91     255.255.255.0    172.29.37.255
SLIP/sl0         DOWN  0.0.0.0          255.0.0.0        (N/A)
ATM/atm0         UP    172.1.1.201      255.255.255.0    172.1.1.255

mgx2.1.7.PXM.a > dspcons
This End        Node Name       Other End       Status

2.1.0.10        mgx2            7.34.0.34       OK
7.34.0.34       mgx2            2.1.0.10        OK

mgx2.1.7.PXM.a > dspcon 2.1.0.10

Conn Par Addr       : 2.1.0.10
Vc Index            : 805306369
Conn SM Addr        : Ept:      vpi = 0 vci = 10 vpc = 0
ifNum = 0x20001    conNum = 0x7fff     glcn = 0x2c1      lcn = 26
qosFwd = 263 qosBwd = 263 pcrFwd = 353208 pcrBwd = 353208 mcrFwd =
0 mcrBwd
 = 0

Remote Node Name    : mgx2
Remote Conn PAR Addr: 7.34.0.34
Remote Conn SM  Addr: Ept:      vpi = 0 vci = 34 vpc = 0
ifNum = 0x70022    conNum = 0x7fff     glcn = 0x2c0      lcn = 0
qosFwd = 263 qosBwd = 263 pcrFwd = 353208 pcrBwd = 353208 mcrFwd =
0 mcrBwd
= 0

OE VC Index         : 805306369
Oper Status         : OK
Conn Failure Reason :
RRT Failure Reason  :
Admin Status        : UP
Route               :
```

Setting Up Connections Between Service Modules and the RPM

To complete a RPM-to-service module connection, configure the connection between the service module and the PXM.

Types of Service Modules

Service modules can be of various types, including FRSM (Frame Relay Service Module), AUSM (ATM UNI Service Module), and VISM (Voice Interworking Service Module).

- AUSM—The AUSM-8T1/E1 is a multipurpose card that supports up to 8 T1 or E1 ports.

- VISM—VISM is a multi-DSP, co-processing card and software package that adds voice over IP or voice over ATM AAL2 capabilities to the MGX 8850 platform. The MGX 8850 uses this new feature card along with LAN/WAN routing capabilities to provide a 192/240 channel gateway for VoIP packetized voice traffic to and from TDM traffic.
- FRSM—The FRSM is a two-card set consisting of an FRSM front card (channelized or fractional, T1 or E1, 8 port) and either an 8T1, or 8E1 port adapter back card. The FRSM converts Frame Relay packets into ATM cells. Other FRSMs are available with T3/E3, channelized T3, V.35, X21, and HSSI interfaces of varying supported speeds, depending upon service module type.
- FRSM-VHS—The FRSM-VHS is a two-card set consisting of an FRSM-VHS front card (channelized or fractional, T3 or E3, 8 port) and either a 2T3, 2E3, HS1, HS2 or 2CT3 port adapter back card. The FRSM converts Frame Relay packets into ATM cells.

Data Forwarding to RPMs

Service modules can be configured to forward data to the RPMs in one of two modes: port forwarding or connection forwarding.

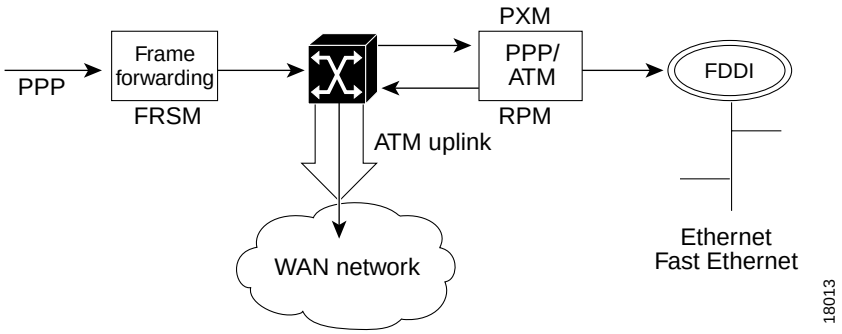
FRSM Frame Aggregation: Port Forwarding

In this mode, all frames received on a port are forwarded to the router for L3 processing. For example, a FRSM T1 could be configured for PPP IP access, by doing the following.

1. Setting up a frame forwarding (FF) connection from a FRSM T1 port to the RPM cellbus address on VPI/VCI.
2. Configuring the router to terminate PPP frames forwarded over an ATM connection on the ATM Deluxe Port Adaptor port on VCI 0/xFrame-forwarding (a proprietary method whereby all HDLC frames received on a port are converted to ATM AAL5 frames with a null encapsulation and sent over a single VC). Cisco has already implemented code to terminate frame-forwarded PPP over ATM.

   The data flow for a PPP connection destined for the RPM is shown in the figure below. The packet enters the FRSM module as PPP and is frame forwarded to the RPM. The RPM receives the packet in PPP over ATM because MGX 8850 internal connectivity is ATM. The RPM runs software that works with PPP over ATM encapsulation, allowing the router to reach the IP layer and route the packet to its destination (such as the Internet). Packets then destined to the Internet via a WAN network are then sent back to the PXM, and out the ATM uplink.

Figure 6-2 Internal Path of a PPP Packet Destined for RPM



PPP over ATM Example

In this PPP over ATM example, the FRSM is in slot 18 and RPM A is in slot 12. A serial port on Router B is connected to the FRSM line 1.

```
***
```

Router B (connected to line 1 of FRSM) configuration example:

```
interface Serial5/0
ip address 192.168.100.2 255.255.255.0
encapsulation ppp
```

```
***
```

The following is an example of a FRSM configuration. (See FRSM documentation for complete command syntax.)

Step 1 Configure the line.

```
SQureshi.1.18.FRSM.a> addln 1
```

Step 2 Configure a frame-forwarding port on the line.

```
SQureshi.1.18.FRSM.a> addport 1 1 2 1 24 3
```

Step 3 Configure a frame-forwarding channel from the port to the RPM.

Step 4 Connect DLCI 1000 on the port to a unique VCI on the RPM, using VPI 0.

```
SQureshi.1.18.FRSM.a> addcon 1 1000 1536000 5 2 1 2 SQureshi.12.1.0.1001
```

```
***
```

RPM configuration example:

```
interface Virtual-Template12/1
ip address 192.168.100.12 255.255.255.0
!
interface Switch12/1.100 point-to-point
atm pvc 100 0 1001 aal5ciscoppp Virtual-Template12/1
```

```
!
rpmrscprtn par 100 100 0 255 0 3840 4080
addcon vcc Switch 12/1.100 1001 rslot 18 1 0 1000 master local

***
```

The following example displays how to verify connectivity.

```
RPM A--
rpm_slot12# show atm vc 100
Switch12/1.100:VCD:100, VPI:0, VCI:1001
UBR, PeakRate:149760
AAL5-CISCOPPP, etype:0x9, Flags:0xC2A, VCmode:0x0
OAM frequency:0 second(s)
InARP DISABLED
Transmit priority 4
InPkts:57, OutPkts:90, InBytes:1828, OutBytes:2068
InPRoc:57, OutPRoc:90
InFast:0, OutFast:0, InAS:0, OutAS:0
InPktDrops:0, OutPktDrops:0
CrcErrors:0, SarTimeOuts:0, OverSizedSDUs:0
OAM cells received:0
OAM cells sent:0
Status:UP
PPP:Virtual-Access12/1 from Virtual-Template12/1
rpm_slot12#show interface Virtual-Template12/1
Virtual-Access12/1 is up, line protocol is up
  Hardware is Virtual Access interface
  Internet address is 192.168.100.12/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
  DTR is pulsed for 5 seconds on reset
  LCP Open
  Open:IPCP
  Bound to Switch12/1.100 VCD:100, VPI:0, VCI:1001
  Cloned from virtual-template:1
  Last input 00:00:07, output never, output hang never
  Last clearing of "show interface" counters 00:06:17
  Queueing strategy:fifo
  Output queue 0/40, 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
     59 packets input, 1632 bytes, 0 no buffer
     Received 59 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     92 packets output, 2100 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions

rpm_slot12#ping 192.168.100.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.100.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
rpm_slot12#sh ip ro
...
     192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C       192.168.100.0/24 is directly connected, Virtual-Access12/1
C       192.168.100.2/32 is directly connected, Virtual-Access12/1


Router B --
router_B#sh int s5/0
Serial5/0 is up, line protocol is up
  Hardware is M4T
  Internet address is 192.168.100.2/24
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, crc 16, loopback not set, keepalive set (10 sec)
  LCP Open
  Listen:CDPCP
  Open:IPCP
  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  0/1/256 (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
     35953 packets input, 529169 bytes, 0 no buffer
     Received 35639 broadcasts, 0 runts, 1 giants, 0 throttles
     211 input errors, 176 CRC, 0 frame, 0 overrun, 0 ignored, 35 abort
     36172 packets output, 487073 bytes, 0 underruns
     0 output errors, 0 collisions, 2465 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2475 carrier transitions     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up

router_B#sh ip ro
...
     192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.100.12/32 is directly connected, Serial5/0
C       192.168.100.0/24 is directly connected, Serial5/0
router_B#ping 192.168.100.12

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.100.12, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms


FRSM --
SQureshi.1.18.FRSM.a > dsplns

  Line  Conn      Type     Status/Coding      Length     XmtClock Alarm Stats
        Type                                             Source         Alarm
  ----  ----- ------------ ------ -------- ------------- -------- ----- -----
  18.1  RJ-48 dsx1ESF         Ena/dsx1B8ZS 0-131 ft      LocalTim  No    No
  18.2  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.3  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.4  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.5  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.6  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.7  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.8  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim

  LineNumOfValidEntries:8

Syntax :dsplns
```

```
SQureshi.1.18.FRSM.a > dspports

Port     Ena/Speed EQServ SignalType   T391 T392 N391 N392 N393  Type    Alarm ELMI
                   Ratio
-------- --- ----- ------ ------------ ---- ---- ---- ---- ---- -------- ----- ----
18.1.1   Add/1536k   1    NoSignaling   10   15    6    3    4 frForwar  No    Off

  Number of ports:             1

  PortDs0UsedLine1:            0x00ffffff
  PortDs0UsedLine2:            0x00000000
  PortDs0UsedLine3:            0x00000000
  PortDs0UsedLine4:            0x00000000
  PortDs0UsedLine5:            0x00000000
  PortDs0UsedLine6:            0x00000000
  PortDs0UsedLine7:            0x00000000
  PortDs0UsedLine8:            0x00000000
  PortNumNextAvailable:        119

Syntax :dspports

SQureshi.1.18.FRSM.a > dspchans

      DLCI      Chan EQ  I/EQDepth  I/EQDEThre  I/EECNThre  Fst/ DE Type  Alarm
  ------------- ---- -- ----- ----- ----- ----- ----- ----- --- --- ----- -----
  18.1.1.1000   101  2  65535/65535 32767/32767  6553/6553  Dis/Dis frFor  No

  Number of channels:   1

  ChanNumNextAvailable: 30

Syntax :dspchans

*****
```

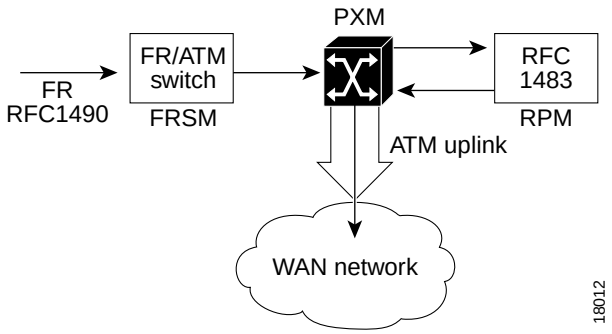
Connection Forwarding

In this mode, all frames received on a given connection are forwarded to the router using the appropriate ATM encapsulation. For example, Frame Relay connections on a FRSM port could be forwarded to the RPM by

- Translating a Frame Relay connection to an ATM connection or service interworking (FRF.8)
- Configuring DLCI to the RPM cellbus address with VPI/VCI 0/x
- Configuring the RPM to terminate Frame Relay to ATM connections (RFC 1483) on the ATM interface on VCI 0/x

The data flow for a native Frame Relay connection destined to the RPM is shown in Figure 6-3. This data flow is identical to that of PPP packets, but the encapsulation techniques are different. Standard Frame Relay is encapsulated using RFC1490. When a packet is received at the FRSM that has been encapsulated using RFC1490, the standard FR-ATM service interworking translation mode (FRF.8) is performed so that when the packet is forwarded to the RPM it is encapsulated using RFC1483. The router also reads RFC1483, enabling it to reach the IP layer, and route the packet.

Figure 6-3 Path of a Native Frame Relay Connection



Frame over ATM Example

In this example, the FRSM-8T1 is in slot 18 of the MGX 8850, while the RPM is in slot 12.

A Frame Relay router (connected to line 1 of FRSM) configuration example follows:

```
interface Serial0
ip address 192.168.101.2 255.255.255.0
encapsulation frame-relay IETF

***
```

The following is an example of a FRSM configuration. (See FRSM documentation for complete command syntax.)

Step 1 Configure the line.

```
SQureshi.1.18.FRSM.a> addln 1
```

Step 2 Configure a Frame Relay port on the line, with StrataLMI signaling.

```
SQureshi.1.18.FRSM.a> addport 1 1 2 1 24 1
SQureshi.1.18.FRSM.a> xcnfport -pt 1 -sig 3
```

Step 3 Configure a service-interworking or network-interworking channel from the port to the RPM. Connect each DLCI on the port to a unique VCI on the RPM, using VPI 0.

```
SQureshi.1.18.FRSM.a> addcon 1 212 1536000 3 2 1 2 SQureshi.12.1.0.101

***
```

RPM configuration example:

```
interface Switch12/1.101 multipoint
ip address 192.168.101.12 255.255.255.0
atm pvc 101 0 101 aal5snap inarp
!
rpmrscprtn par 100 100 0 255 0 3840 4080
addcon vcc Switch 12/1.101 101 rslot 18 1 0 212 master local

***
```

To verify connectivity:

```
RPM --
rpm_slot12#ping 192.168.101.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.101.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms
rpm_slot12#sh arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.101.2           0    0 / 101        ATM    Switch12/1.101
rpm_slot12#

Frame Relay router --
rpm7206_2#show frame-relay map
Serial5/0 (up):ip 192.168.101.12 dlci 212(0xD4,0x3440), dynamic,
              broadcast,
              IETF, BW = 1536000, status defined, active
rpm7206_2#ping 192.168.101.12

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.101.12, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
rpm7206_2#

FRSM --
SQureshi.1.18.FRSM.a > dspchans

      DLCI      Chan EQ  I/EQDepth  I/EQDEThre  I/EECNThre  Fst/ DE Type  Alarm
  ------------- ---- -- ----- ----- ----- ----- ----- ----- --- --- ----- -----
  18.1.1.212    121  2  65535/65535 32767/32767  6553/6553  Dis/Dis SIW-X  No

  Number of channels:   1

  ChanNumNextAvailable: 26

Syntax :dspchans



SQureshi.1.18.FRSM.a > dspports

Port     Ena/Speed EQServ SignalType   T391 T392 N391 N392 N393  Type    Alarm ELMI
                   Ratio
-------- --- ----- ------ ------------ ---- ---- ---- ---- ---- -------- ----- ----
18.1.1   Add/1536k   1    StrataLMI      10   15    6    3    4 frameRel  No    Off

  Number of ports:             1

  PortDs0UsedLine1:            0x00ffffff
  PortDs0UsedLine2:            0x00000000
  PortDs0UsedLine3:            0x00000000
  PortDs0UsedLine4:            0x00000000
  PortDs0UsedLine5:            0x00000000
  PortDs0UsedLine6:            0x00000000
  PortDs0UsedLine7:            0x00000000
  PortDs0UsedLine8:            0x00000000
  PortNumNextAvailable:        83

Syntax :dspports
```

```
SQureshi.1.18.FRSM.a > dsplns

  Line  Conn      Type     Status/Coding      Length     XmtClock Alarm Stats
        Type                                             Source         Alarm
  ----  ----- ------------ ------ -------- ------------- -------- ----- -----
  18.1  RJ-48 dsx1ESF         Ena/dsx1B8ZS 0-131 ft      LocalTim  No    No
  18.2  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.3  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.4  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.5  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.6  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.7  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
  18.8  RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim

  LineNumOfValidEntries:8

Syntax :dsplns


SQureshi.1.18.FRSM.a >
```

ATM Service

The ATM UNI Service Modules (AUSMs) provide native ATM UNI (compliant with ATM Forum v3.0 and v3.1) interfaces at T1 and E1 speeds, with eight ports per card, providing up to16 Mbps of bandwidth for ATM service interfaces. This is compliant with the physical and ATM layer, but not with signaling.

Consistent with Cisco Intelligent QoS Management features, AUSM cards support per-VC queuing on ingress and multiple class-of-service queues on egress. AUSM cards fully support continuous bit rate (CBR), variable bit rate (VBR), unspecified bit rate (UBR), and available bit rate (ABR) service classes.

The AUSM-8 cards also support ATM Forum-compliant inverse multiplexing for ATM (IMA). This capability enables multiple T1 or E1 lines to be grouped into a single high-speed ATM port. This N x T1 and N x E1 capability fills the gap between T1/E1 and T3/E3, providing bandwidth up to 12 Mbps (N x T1) or 16 Mbps (N x E1) without requiring a T3/E3 circuit.

A single AUSM card can provide hot standby redundancy for all active AUSM cards of the same type in the shelf (1:N redundancy).

AUSM modules are supported by standards-based management tools, including SNMP, TFTP (for configuration and statistics collection), and a command line interface. The Cisco WAN Manager application also provides full graphical user interface support for connection management, and CiscoView software provides equipment management.

Table 6-1 summarizes the key attributes of the AUSM cards.

Table 6-1 AUSM Card Specifications

	AUSM-8T1	**AUSM-8E1**
Physical interface	T1	E1
Number of ports	8	8
Line Speed	1.544 Mbps +/- 50 bps	2.048 Mbps +/- 50 bps
Logical ports	8 maximum	8 maximum
Maximum connections	1000	1000

Table 6-1 AUSM Card Specifications (continued)

	AUSM-8T1	AUSM-8E1
Line coding	B8ZS AMI	HDB3 AMI
BERT	Yes	Yes
Loopback	Extended loopback pattern generation and verification	Loop-up, loop-down pattern generation and verification
Redundancy	1:N	1:N
Back Card	RJ48-8T1	RJ48-8E1

Setting Up the FRSM Connections to the PXM

The following procedure may be used for configuring the FRSM connections to the PXM. The AUSM is slightly different and is in the section "Setting Up the AUSM Connection to the PXM," later in this chapter.

Step 1 Go to the PXM and login.

Step 2 Enter the **cc** command to go to the slot where the service module is.

```
8250name.1.slot.FRSM.a> cc 12
```

Step 3 Enter **dsplns** to view the line interfaces.

```
8250name.1.slot.FRSM.a> dsplns
```

Step 4 To establish the physical connection between the service module and the PXM, enter the **addln** command to enable a line.

```
8250name.1.slot.FRSM.a> addln 2
```

Step 5 Enter the **dspports** command to display ports.

```
8250name.1.slot.FRSM.a> dspports
```

Step 6 Enter the **addport** command to add a port.

```
8250name.1.slot.FRSM.a> addport port_num line_num port_type
```

Step 7 Enter the **dspports** command to display ports.

```
8250name.1.slot.FRSM.a> dspports
```

Step 8 Enter the **xcnfport** command to choose signaling type.

```
8250name.1.slot.FRSM.a> xcnfport "-pt" (PortNum) -sig (type)"
<cr>
```

Step 9 Configure the logical link between the service module and the PXM by entering the **addcon** command.

```
8250name.1.slot.FRSM.a> addcon "port dlci cir chan_type [CAC]
[Controller_Type][mastership][remoteConnId]"
```

The parameters are

- **port number**—values ranging from 1-192 are accepted for T1 and 1-248 for E1

- **DLCI number**—value ranging from 0 to 1023
- **committed rate**—0-1536000 bps for T1; 0-2048000 bps for E1
- **chan type**—values 1-5:
  - 1=NIW
  - 2=SIW-transparent
  - 3=SIW-xlation
  - 4=FUNI
  - 5=frForward
- **CAC—**Connection Admission Control (optional); 1 = enable, 2 = disable (default)
- **Controller Type (Signaling)**—1:PVC (PAR) - Default , 2:SPVC (PNNI)
- **mastership**—1 for master, 2 for slave
- **Remote end Connection ID**—Formated as follows:
  - NodeName.SlotNo.PortNo.Dlci OR
  - NodeName.SlotNo.PortNo.ControllerId.Dlci for FR end point OR
  - NodeName.SlotNo.PortNo.VPI.VCI for ATM end point.

  Where controller ID can be 1(PAR), 2(PNNI), 3(TAG)

FRSM-PXM Configuration Example

The following example displays a FRSM-PXM configuration.

```
popeye01.1.2.FRSM.a > dspcd

    ModuleSlotNumber:           2
    FunctionModuleState:        Active
    FunctionModuleType:         FRSM-8T1
    FunctionModuleSerialNum:    788039
    FunctionModuleHWRev:        ab
    FunctionModuleFWRev:        5.0.00_04Feb99_2_CIR
    FunctionModuleResetReason:  Reset by ASC from Cell Bus
    LineModuleType:             LM-RJ48-8T1
    LineModuleState:            Present
    mibVersionNumber:           20
    configChangeTypeBitMap:     CardCnfChng, LineCnfChng
    cardIntegratedAlarm:        Clear
    fab number:                 28-2069-02

popeye01.1.2.FRSM.a >

popeye01.1.2.FRSM.a > addln

ERR : incorrect number of parameters (not enough)
Syntax :    addln "line_num"
            line number -- values ranging from 1-8 are accepted, for FRSM_8

    possible errors are :
    a) illegal/invalid parameters
    b) line aleady exists
```

```
popeye01.1.2.FRSM.a > addln 1

popeye01.1.2.FRSM.a > cnfln

ERR : incorrect number of parameters (not enough)
Syntax :    cnfln "line_num line_code line_len clk_src [E1-signaling]"
            line number -- values ranging from 1-8 are accepted, for FRSM_8
            line code -- 2 for B8ZS (T1),
                          3 for HDB3 (E1),
                          4 for AMI (T1/E1)
            line length -- 10-15 for T1,
                          8 for E1 with SMB line module,
                          9 for E1 with RJ48 line module
            clock source -- clock source : 1 for loop clock, 2 for local clock
            E1 signaling -- CAS: CAS, no CRC; CAS_CRC: CAS, with CRC;
                            CCS: CCS, no CRC; CCS_CRC: CCS, with CRC
                            CLEAR : Clear E1

    possible errors are :
    a) illegal/invalid parameters
    b) line doesn't exist, use addln to add line first
    c) loopback/bert is on

popeye01.1.2.FRSM.a > cnfln 1 2 10 2

popeye01.1.2.FRSM.a > dsplns

    Line  Conn      Type     Status/Coding      Length     XmtClock Alarm Stats
          Type                                             Source         Alarm
    ----  ----- ------------ ------ -------- ------------- -------- ----- -----
    2.1   RJ-48 dsx1ESF         Mod/dsx1B8ZS 0-131 ft      LocalTim  No    No
    2.2   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.3   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.4   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.5   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.6   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.7   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    2.8   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim

    LineNumOfValidEntries: 8

Syntax : dsplns

popeye01.1.2.FRSM.a > addport

ERR : incorrect number of parameters (not enough)
Syntax :    addport "port_num line_num ds0_speed begin_slot num_slot port_type"
            port number -- values ranging from 1-192 are accepted for T1 and 1-248
                for E1
            line number -- value ranging from 1 to 8
            DS0 speed -- 1 for 56K, 2 for 64K
            beginning slot -- beginning time slot in 1 base
            number of slot -- number of DS0 time slots assigned to
            port type -- values 1-3, 1=frame relay, 2=FUNI mode-1a, 3=frForward


    possible errors are :
    a) illegal/invalid parameters
    b) port already exists
    c) line not enabled
    d) line not channelized

popeye01.1.2.FRSM.a > addport 1 1 2 1 2 1
```

```
popeye01.1.2.FRSM.a > upport

ERR : incorrect number of parameters (not enough)
Syntax :    upport "port_num "
            port number -- values ranging from 1-192 are accepted for T1 and 1-248
    for E1

    possible errors are :
    a) illegal/invalid parameter for port number
    sprint01.1.2.FRSM.a > upport 1

popeye01.1.2.FRSM.a > dspports

Port     Ena/Speed EQServ SignalType   T391 T392 N391 N392 N393  Type    Alarm ELMI
                   Ratio
-------- --- ----- ------ ------------ ---- ---- ---- ---- ---- -------- ----- ----
2.1.1    Mod/ 128k   1    NoSignaling  10   15    6    3    4  frameRel   No   Off

    Number of ports: 1

    PortDs0UsedLine1:             0x00000003
    PortDs0UsedLine2:             0x00000000
    PortDs0UsedLine3:             0x00000000
    PortDs0UsedLine4:             0x00000000
    PortDs0UsedLine5:             0x00000000
    PortDs0UsedLine6:             0x00000000
    PortDs0UsedLine7:             0x00000000
    PortDs0UsedLine8:             0x00000000
    PortNumNextAvailable:         19

Syntax : dspports

popeye01.1.2.FRSM.a > addcon

ERR : incorrect number of parameters (not enough)
Syntax :    addcon "port dlci cir chan_type [CAC][Controller_Type][mastership]
                [remoteConnId]"
            port number -- values ranging from 1-192 are accepted for T1 and 1-248
                for E1
            DLCI number -- value ranging from 0 to 1023
            committed rate -- 0-1536000 bps for T1; 0-2048000 bps for E1
            chan type -- values 1-5, 1=NIW 2=SIW-transparent 3=SIW-xlation 4=FUNI 5
                =frForward
            CAC -- Connection Admission Control (optional); 1 = enable, 2 = disable
                (default)
            Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
            mastership -- 1 for master, 2 for slave
            Remote end Connection ID -- Format :
             NodeName.SlotNo.PortNo.Dlci OR
             NodeName.SlotNo.PortNo.ControllerId.Dlci for FR end point OR
             NodeName.SlotNo.PortNo.VPI.VCI for ATM end point.
             Where controller ID can be 1(PAR),2(PNNI),3(TAG)

    possible errors are :
    a) Illegal/Invalid parameters
    b) channel already exists
    c) port may not be up

popeye01.1.2.FRSM.a > addcon 1 100 128000 2 2 1 2 popeye01.0.1.0.100
```

Note SlotNo = 0 (zero) which points to the active PXM.

Setting Up the AUSM Connection to the PXM

Use the following procedure to establish an ATM UNI/NNI connection using the AUSM card. The connection is between a T1 or E1 ATM UNI on the AUSM card and an ATM service interface elsewhere in the IPX/BPX network.

Step 1 Log in to the AUSM card.

Step 2 To add the line, enter the **addln** command.

```
RPM-3 (configure)# addln <line # (between 1 and 8)>
```

Step 3 Enter the **cnfln** command for line code, line length, and clock source.

Step 4 Enter the **upport** command, specifying the port to be upped.

Step 5 Enter the **cnfportq** command to set up egress queues.

The parameters are

- Port number (1–8)
- Queue number (1–16)
- Queue priority

  0 = disable queue
  1 = high priority, always serve
  2 = best available
  3 = Min. guaranteed bandwidth
  4 = Min. guaranteed bandwidth with max. rate shaping
  5 = CBR with smoothing
- Service sequence number (1–16)
- Max. queue depth (1–8000)
- CLP low threshold (1–8000)
- CLP high threshold (1–8000)
- EFCI threshold (1–8000)

Step 6 Enter the **addcon** command to add the connection.

The parameters are

- Logical Connection (LCN 16-271)
- Connection Type (1 = vpc, 2 = vcc)
- Port Number (1–4)
- VPI (0–255)
- VCI (0–65535)
- Service Type (1 = cbr, 2 = vbr, 3 = abr)
- Queue Number (1–16)

Step 7 To configure UPC, use one of the following **cnfupc** commands.

```
cnfupc cbr
cnfupc vbr
cnfupc abr
```

Step 8 Enter the **cnfchanfst** command to configure ForeSight.

Step 9 If queue depths need to be changed, enter the **cnfchanq** command.

Step 10 To add IMA ports, enter the **addimagrp** command.

AUSM-PXM Configuration Example

The following example displays an AUSM to PXM configuration.

```
AUSM configuration

popeye01.1.3.AUSMB8.a > dspcd

ModuleSlotNumber:            3
FunctionModuleState:         Active
FunctionModuleType:          AUSMB-8T1
FunctionModuleSerialNum:     023113
FunctionModuleHWRev:         aa
FunctionModuleFWRev:         10.0.00_12Feb99_1
FunctionModuleResetReason:   Reset by ASC from Cell Bus
LineModuleType:              LM-RJ48-8T1
LineModuleState:             Present
mibVersionNumber:            20
configChangeTypeBitMap:      CardCnfChng, LineCnfChng
cardIntegratedAlarm:         Major
cardMajorAlarmBitMap:        Line Alarm
cardMinorAlarmBitMap:        Channel failure
fab number:                  28-2580-01


popeye01.1.3.AUSMB8.a > addln

ERR : incorrect number of parameters (not enough)
Syntax :    addln "line_num"
            line number -- values ranging from 1-8 are accepted, for AUSM-8T1/8E1,
                IMATM-T3T1/E3E1

    possible errors are :
    a) illegal/invalid parameters
    b) line aleady exists

popeye01.1.3.AUSMB8.a > addln 1

popeye01.1.3.AUSMB8.a > cnfln 1

ERR : incorrect number of parameters (not enough)
Syntax :    cnfln "line_num line_code line_len clk_src [E1-signaling]"
            line number -- values ranging from 1-8 are accepted, for AUSM-8T1/8E1,
                IMATM-T3T1/E3E1
            line code --    2 for B8ZS (T1),
                            3 for HDB3 (E1)
            line length -- 10-15 for T1, 8 for E1 with SMB module,
                            9 for E1 with RJ48 line module
            clock source -- clock source : 1 for loop clock, 2 for local clock
            E1 signaling -- CCS: CCS, no CRC; CCS_CRC: CCS, with CRC;
                           CLEAR: Clear E1

    possible errors are :
    a) illegal/invalid parameters
    b) line doesn't exist, use addln to add line first
    c) loopback/bert is on
```

```
popeye01.1.3.AUSMB8.a > cnfln 1 2 10 2

popeye01.1.3.AUSMB8.a > dsplns

    Line  Conn      Type     Status/Coding      Length     XmtClock Alarm Stats
          Type                                             Source         Alarm
    ----  ----- ------------ ------ -------- ------------- -------- ----- -----
    3.1   RJ-48 dsx1ESF         Mod/dsx1B8ZS 0-131 ft      LocalTim  Yes   No
    3.2   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.3   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.4   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.5   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.6   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.7   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim
    3.8   RJ-48 dsx1ESF         Dis/dsx1B8ZS 0-131 ft      LocalTim

    LineNumOfValidEntries: 8

Syntax : dsplns

popeye01.1.3.AUSMB8.a > addport

ERR : incorrect number of parameters (not enough)
Syntax :    addport "port_num port_type line_num"
            port number -- values ranging from 1-8
            Port Type -- 1 - UNI, 2 - NNI
            line number -- value ranging from 1 to 8

    possible errors are :
    a) Incorrect parameters
    b) Line not present
    c) Line part of another IMA port or ATM port
    d) Port already in use

popeye01.1.3.AUSMB8.a > addport 1 1 1

popeye01.1.3.AUSMB8.a > dspports

    List of ATM ports:
    ==================
    Port PortType Line# Portenable  Speed  PortState
    ---- -------- ----- -----------  -----  ---------
    3.1   UNI      1    UP           3622  Active

No IMA ports are currently active

Syntax : dspports

popeye01.1.3.AUSMB8.a > addcon

ERR : incorrect number of parameters (not enough)
Syntax :    addcon "port_num vpi vci conn_type service_type [Controller_Type] [mast
                ership] [remoteConnId]"
            port number -- values ranging from 1-8
            Channel VPI -- Virtual Path Identifier: 0 - 255
            Channel VCI -- Virtual Channel Identifier: 0 - 65535 for VCC, * for VPC
            Connection Type -- Connection Type : 0 - VCC , non zero - Local
                               VP Id of the VPC (1 to 20)
            Service Type -- Service Type: 1 - CBR, 2 - VBR, 3 - ABR, 4 - UBR
            Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
            Mastership -- 1 for master, 2 for slave Default:Slave
            Remote end Connection ID -- Format : NodeName.SlotNo.PortNo.ExternalConnId
```

```
    possible errors are :
    a) Illegal/Invalid parameters
    b) channel already exists
    c) port may not be up

popeye01.1.3.AUSMB8.a > addcon 1 20 200 0 2 1 2 popeye01.0.1.20.200

Local Connection Id is : popeye01.3.1.20.200
```

Note This example displays how to add the AUSM connection to the active PXM.

Note SlotNo = 0 (zero) which points to the active PXM.

ATM Configuration Examples

The following sections contain examples of ATM interface configurations:

- Example of PVCs with AAL5 and LLC/SNAP Encapsulation
- Example of PVCs in a Fully Meshed Network

For examples of emulated LAN configurations, refer to the *MGX 8850 Wide Area Switch Installation and Configuration*.

Example of PVCs with AAL5 and LLC/SNAP Encapsulation

The following example shows how PVCs are created on the ATM interface 5/1 using LLC/SNAP encapsulation over AAL5. ATM interface 5/1 (IP address 1.1.1.2 255.255.255.0) connects with the ATM interface (IP address 1.1.1.1 255.255.255.0) at the other end of the connection. The static map list named *atm1* declares that the next node is a broadcast point for multicast packets from IP.

```
interface switch 5/1
ip address 1.1.1.2 255.255.255.0
 map-group atm1
 atm pvc 2 0 1 aal5snap
!
no ip classless
!
map-list atm1
 ip 1.1.1.1 atm-vc 2 broadcast
```

The following example displays a typical ATM configuration for a PVC.

```
interface switch 5/1
ip address 131.108.168.112 255.255.255.0
map-group atm
atm pvc 2 2 2 aal5snap
atm pvc 6 6 6 aal5snap
atm pvc 7 7 7 aal5snap
clns router iso-igrp comet
!
router iso-igrp comet
net 47.0004.0001.0000.0c00.6666.00
!
router igrp 109
```

```
network 131.108.0.0
!
ip domain-name CISCO.COM
!
map-list atm
ip 131.108.168.110 atm-vc 7 broadcast
clns 47.0004.0001.0000.0c00.6e26.00 atm-vc 6 broadcast
ip 131.108.168.120 atm-vc 2 broadcast
```

using <*protocol*> <*address*> atm-vc 2 broadcast

where

- protocol = ip

Example of PVCs in a Fully Meshed Network

The configurations for RPMs A, B, and C follow. In this example, the RPMs are configured to use PVCs. *Fully meshed* indicates that each network node has either a physical circuit or a virtual circuit connecting it to every other network node.

Note that the two map-list statements configured in RPM A identify the ATM addresses of RPMs B and C. The two map-list statements in RPM B identify the ATM addresses of RPMs A and C. The two map list statements in RPM C identify the ATM addresses of RPMs A and B.

Fully Meshed ATM Configuration Example

In the following example, RPM A, RPM B, and RPM C are located in the same MGX 8850 chassis.

RPM A (slot 4)

```
ip routing
!
interface Switch 4/1
ip address 131.108.168.1 255.255.255.0
atm pvc 10 0 10 aal5snap
atm pvc 3 0 20 aal5snap
map-group test-a
!
map-list test-a
ip 131.108.168.2 atm-vc 10 broadcast
ip 131.108.168.3 atm-vc 3 broadcast
!
rpmrscprtn PAR 100 100 1 255 0 3840 4080
addcon vcc sw4/1 10 rslot 5 1 0 20
addcon vcc sw4/1 20 rslot 3 1 0 21
```

RPM B (slot 5)

```
ip routing
!
interface Switch 5/1
ip address 131.108.168.2 255.255.255.0
```

```
atm pvc 10 0 20 aal5snap
atm pvc 3 0 21 aal5snap
map-group test-b
!
map-list test-b
ip 131.108.168.1 atm-vc 10 broadcast
ip 131.108.168.3 atm-vc 3 broadcast
!
rpmrscprtn PAR 100 100 1 255 0 3840 4080
addcon vcc sw5/1 20 rslot 4 1 0 10 master local
addcon vcc sw5/1 21 rslot 3 1 0 22
```

RPM C (slot 3)

```
ip routing
!
interface Switch 3/1
ip address 131.108.168.3 255.255.255.0
atm pvc 3 0 21 aal5snap
atm pvc 4 0 22 aal5snap
map-group test-c
!
map-list test-c
ip 131.108.168.1 atm-vc 3 broadcast
ip 131.108.168.2 atm-vc 4 broadcast
!
rpmrscprtn PAR 100 100 1 255 0 3840 4080
addcon vcc sw3/1 21 rslot 4 1 0 20 master local
addcon vcc sw3/1 22 rslot 5 1 0 21 master local
```

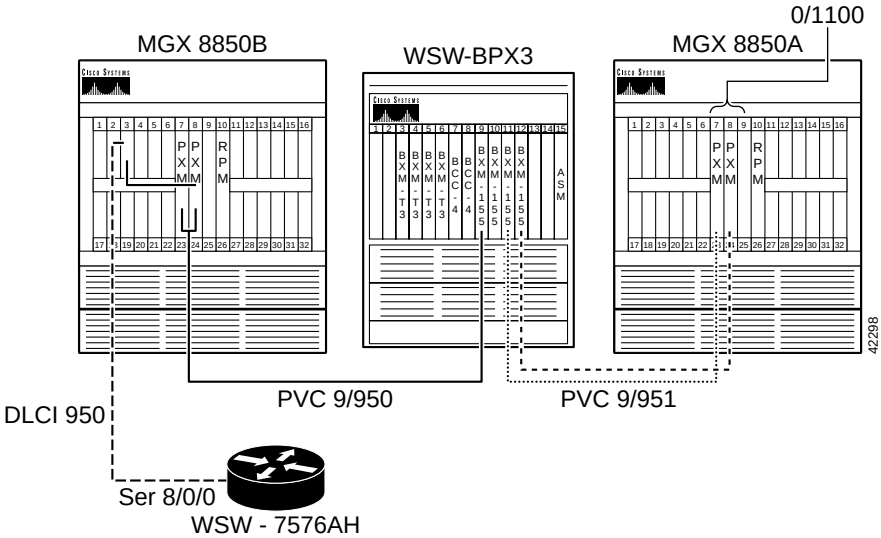
RPM-to-Service Module DAX Connections

All the configuration examples in the following section illustrate designs where datagrams enter and leave the RPM via the switch interface, get switched on the local PXM, and leave and enter a Service Module on the same MGX 8850 shelf.

RPM-to-FRSM-8T1 ATM/Frame Relay SIW DAX Connection

In this example, IP connectivity is established between a Cisco 3620 router and the RPM blade on the MGX 8850. The T1 WAN interface card (WIC) (serial 0/0) on the Cisco 3620 is connected to physical line 1 on the Frame Relay Service Module (FRSM)-8T1 in slot 11 on the MGX 8850. A digital access and cross-connect (DAX) connection is built through the PXM to switch the cells between the FRSM and the RPM switch interface.

Figure 6-4 RPM-to-FRSM-8T1 ATM/Frame Relay SIW DAX Connection



Configuring the FRSM Interface

This example shows how to configure the FRSM interface, enable the physical line, enable a logical port on the line, and adjust the parameters as necessary.

```
mgx8850a.1.11.FRSM.a > addln 1
     mgx8850a.1.11.FRSM.a > dspln 1
     LineNum:                    1
       LineConnectorType:         RJ-48
       LineType:                  dsx1ESF
       LineEnable:                Enabled
       LineCoding:                dsx1B8ZS
       LineLength:                0-131 ft
       LineXmtClockSource:        LocalTiming
       LineLoopbackCommand:       NoLoop
       LineSendCode:              NoCode
       LineUsedTimeslotsBitMap:   0x0
       LineLoopbackCodeDetection: codeDetectDisabled
       LineBertEnable:            Disable
```

The logical port consists of timeslots 1 through 6, and uses Gang of Four Logical Management Interface (LMI) with Enhanced Local Management Interface (ELMI).

```
Syntax : addport "port_num line_num ds0_speed begin_slot num_slot port_type"
port number -- values ranging from 1-192 are accepted for T1 and 1-248 for E1
              line number -- value ranging from 1 to 8
              DS0 speed -- 1 for 56K,  2 for 64K
              beginning slot -- beginning time slot in 1 base
              number of slot -- number of DS0 time slots assigned to
              port type -- values 1-3, 1=frame relay, 2=FUNI mode-1a, 3=frForward
mgx8850a.1.11.FRSM.a > addport 10 1 2 1 6 1

Syntax : cnfport "portNum lmiSig asyn ELMI T391 T392 N391 N392 N393"
port number -- values ranging from 1-192 are accepted for T1 and 1-248 for E1
              LMI signaling -- (N)one (S)trataLMI au-AnnexAUNI
              du-AnnexDUNI an-AnnexANNI dn-AnnexDNNI
              asyn UPD/UFS -- (UPD = Update Status, UFS = Unsolicited Full Status)
                     (n or 1) = both dis, (y or 2) = UPD en, 3 = UFS en, 4 = both en
```

```
                Enhanced LMI -- (N or n) disable (Y or y) enable
                T391 timer -- value ranging from 5 to 30 sec.
                T392 timer -- value ranging from 5 to 30 sec.
                N391 counter -- value ranging from 1 to 255
                N392 counter -- value ranging from 1 to 10
                N393 counter -- value ranging from 1 to 10, greater than N392

mgx8850a.1.11.FRSM.a > cnfport 10 S n y

mgx8850a.1.11.FRSM.a > dspport 10
SlotNum:                      11
       PortLineNum:                   1
       PortNum:                       10
       PortRowStatus:                 Mod
       PortDs0Speed:                  64k
       PortDs0ConfigBitMap(1stDS0):   0x3f(1)
       PortEqueueServiceRatio:        1
       PortFlagsBetweenFrames:        1
       PortSpeed:                     384kbps
       SignallingProtocolType:        StrataLMI
       AsynchronousMsgs:              UPD_UFS disabled
       T391LineIntegrityTimer:        10
       T392PollingVerificationTimer:  15
       N391FullStatusPollingCounter:  6
       N392ErrorThreshold:            3
       N393MonitoredEventCount:       4
       EnhancedLmi:                   On
       PortState:                     FailedDuetoSignallingFailure
       PortSignallingState:           LMI Failure
       CLLMEnableStatus:              Disable
       CLLMxmtStatusTimer:            0
       portType:                      frameRelay
       PortIngrPercentUtil:           0
       PortEgrPercentUtil:            0
       PortOversubscribed:            False
       PortSvcStatus:                 Disable
       PortSvcInUse:                  Not In-Use
       PortSvcShareLcn:               Card-based
       PortSvcLcnLow:                 0
       PortSvcLcnHigh:                0
       PortSvcDlciLow:                0
       PortSvcDlciHigh:               0

       PortDs0UsedLine1:              0x0000003f
       PortDs0UsedLine2:              0x00000000
       PortDs0UsedLine3:              0x00000000
       PortDs0UsedLine4:              0x00000000
       PortDs0UsedLine5:              0x00000000
       PortDs0UsedLine6:              0x00000000
       PortDs0UsedLine7:              0x00000000
       PortDs0UsedLine8:              0x00000000
       PortNumNextAvailable:          11
```

Configuring the Router Interface

For the router interface, supply the appropriate physical, data-link, and network layer parameters. Because connectivity will be established through Frame Relay/ATM Service Interworking, use Internet Engineering Task Force (IETF) Frame Relay encapsulation on the interface instead of the default Cisco encapsulation, as shown in the following example.

```
wsw-3620a#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-3620a(config)#int s 0/0
     wsw-3620a(config-if)#service-module T1 clock source line
     wsw-3620a(config-if)#service-module T1 framing esf
     wsw-3620a(config-if)#service-module T1 linecode b8zs
     wsw-3620a(config-if)#service-module T1 timeslots 1-6 speed 64
     wsw-3620a(config-if)#encap frame ietf
     wsw-3620a(config-if)#frame-relay qos-autosense
     wsw-3620a(config)#int s 0/0.110 point
     wsw-3620a(config-subif)#frame-relay interface-dlci 110
     wsw-3620a(config-fr-dlci)#exit
     wsw-3620a(config-subif)#ip address 10.97.110.1 255.255.255.0
     wsw-3620a(config-if)#no shut
     wsw-3620a(config-if)#^Z
     wsw-3620a#
     wsw-3620a#sh int s 0/0
     Serial0/0 is up, line protocol is up
       Hardware is QUICC with integrated T1 CSU/DSU
       Description: T1 to MGX8850A FRSM 11.1
       MTU 1500 bytes, BW 384 Kbit, DLY 20000 usec,
          reliability 255/255, txload 1/255, rxload 1/255
      Encapsulation FRAME-RELAY IETF, loopback not set
       Keepalive set (10 sec)
       Restart-Delay is 4294967 secs
       LMI enq sent  30, LMI stat recvd 32, LMI upd recvd 0, DTE LMI up
       LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
       LMI DLCI 1023  LMI type is CISCO  frame relay DTE
       FR SVC disabled, LAPF state down
       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 00:05:11
       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  0/1/256 (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
          32 packets input, 475 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
          34 packets output, 502 bytes, 0 underruns
          0 output errors, 0 collisions, 0 interface resets
          0 output buffer failures, 0 output buffers swapped out
          1 carrier transitions
          DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
     wsw-3620a#sh fram qos-auto

     ELMI information for interface Serial0/0
      Connected to switch:FRSM-8T1   Platform:AXIS   Vendor:Cisco
                   (Time elapsed since last update 00:00:50)
```

Configuring the RPM Interface

Set the traffic shaping for vbr-nrt at 128000 bps peak cell rate (PCR), 64000 bps minimum cell rate (MCR), and 38 cell burst, as shown in the following example.

```
wsw-8850a-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850a-rpm(config)#int switch 1.110 point
     wsw-8850a-rpm(config)#ip address 10.97.110.2 255.255.255.0
```

```
wsw-8850a-rpm(config-subif)#pvc 3620a-frame 0/1100
wsw-8850a-rpm(config-if-atm-)#vbr-nrt 128 64 38
wsw-8850a-rpm(config)#^Z
```

Building the RPM Slave Connection

Build the RPM Slave connection, as shown in the following example.

```
wsw-8850a-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850a-rpm(config)#addcon vcc switch 1.110 1100 rname mgx8850a rslot 11 10 0 110
     wsw-8850a-rpm(config)#^Z
     wsw-8850a-rpm#show switch connections
                                                                                Synch
     lVpi   lVci     remoteNodeName   remoteSlot remoteIf  rVpi   rVci     Status
     0      1100     mgx8850a         11         10        0      110     inSynch
     wsw-8850a-rpm#show switch connections vcc 1100
     ----------------------------------------------------------
     Local Sub-Interface   : 110
     Local VPI             : 0
     Local VCI             : 1100
     Remote Node Name      : mgx8850a
     Remote Slot           : 11
     Remote Interface      : 10
     Remote VPI            : 0
     Remote VCI            : 110
     Routing Priority      : 0
     Max Cost              : 255
     Restricted Trunk Type : none
     Percent Util          : 100
     Remote PCR            : 302
     Remote MCR            : 151
     Remote Percent Util   : 100
     Connection Master     : Remote
     Synch Status          : inSynch
```

Building the FRSM-8T1 Master Connection

The following example specifies that Frame Relay/ATM Service Interworking will be used. The conversion from Frame Relay to ATM and vice versa occurs on the FRSM. Once the connection is configured, adjust policing on the channel by entering the **cnfchanpol** command.

```
Syntax : addcon "port dlci cir chan_type [CAC] [Controller_Type] [mastership]
[remoteConnId]"
              port number -- values ranging from 1-192 are accepted for T1 and 1-248 for
E1
              DLCI number -- value ranging from 0 to 1023
              committed rate -- 0-1536000 bps for T1; 0-2048000 bps for E1
              chan type -- values 1-5, 1=NIW 2=SIW-transparent 3=SIW-xlation 4=FUNI
5=frForward
              CAC -- Connection Admission Control (optional); 1 = enable, 2 = disable
(default)
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              mastership -- 1 for master, 2 for slave
              Remote end Connection ID -- Format :
               NodeName.SlotNo.PortNo.Dlci OR
               NodeName.SlotNo.PortNo.ControllerId.Dlci for FR end point OR
               NodeName.SlotNo.PortNo.VPI.VCI for ATM end point.
               Where controller ID can be 1(PAR),2(PNNI),3(TAG)

     mgx8850a.1.11.FRSM.a > addcon 10 110 64000 3 2 1 1 mgx8850a.10.1.0.1100
```

```
     mgx8850a.1.11.FRSM.a > dspcons
Line     ConnId            Chan EQ  I/EQDepth  I/EQDEThre  I/EECNThre  Fst/ DE Type  Alarm
---- -------------------- ---- -- ----- ----- ----- ----- ----- ----- --- --- ----- -----
1    mgx8850a.11.10.0.110   27  2  65535/65535 32767/32767  6553/6553  Dis/Dis SIW-X  No

     Syntax : cnfchanpol "chan_num cir bc be ibs detag egrat"
              channel number -- value ranging from 16 to 1015
              committed rate -- 0-1536000 bps for T1, 0-2048000 bps for E1
              committed burst -- 0-65535 in bytes
              excess burst -- 0-65535 in bytes
              initial burst -- 0-65535 in bytes. Less or equal to Bc
              DE bit tagging -- 1 for enable, 2 for disable
              Egress Service Rate -- 0-1536000 bps for T1, 0-2048000 bps for E1
     mgx8850a.1.11.FRSM.a > cnfchanpol 27 64000 8000 2000 2000 1 384000
     mgx8850a.1.11.FRSM.a > dspchan 27

       ChanNum:                  27
       ChanRowStatus:            Mod
       ChanPortNum:              10
       ChanDLCI:                 110
       EgressQSelect:            2
       IngressQDepth:            65535
       IngressQDEThresh:         32767
       IngressQECNThresh:        6553
       EgressQDepth:             65535
       EgressQDEThresh:          32767
       EgressQECNThresh:         6553
       DETaggingEnable:          Enabled
       CIR:                      64000
       Bc:                       8000
       Be:                       2000
       IBS:                      2000
       ForeSightEnable:          Disabled
       QIR:                      166
       MIR:                      166
       PIR:                      166
       ChanLocalRemoteLpbkState: Disabled
       ChanTestType:             TestOff
       ChanTestState:            NotInProgress
       ChanRTDresult:            65535 ms
       ChanType:                 SIW-Xlat
       ChanFECNmap:              setEFCIzero
       ChanDEtoCLPmap:           mapCLP
       ChanCLPtoDEmap:           mapDE
       ChanFrConnType:           PVC
       ChanIngrPercentUtil:      100
       ChanEgrPercentUtil:       100
       ChanEgrSrvRate:           384000
       ChanOvrSubOvrRide:        Enabled
       ChanLocalVpi:             0
       ChanLocalVci:             110
       ChanLocalNSAP:            6d677838383530610000000000000000b000a00
       ChanRemoteVpi:            0
       ChanRemoteVci:            1100
       ChanRemoteNSAP:           6d677838383530610000000000000000a000100
       ChanMastership:           Master
       ChanVpcFlag:              Vcc
       ChanConnServiceType:      ATFR
       ChanRoutingPriority:      1
       ChanMaxCost:              255
       ChanRestrictTrunkType:    No Restriction
       ChanConnPCR:              166
       ChanConnMCR:              166
```

```
  ChanConnPercentUti:       100

mgx8850a.1.11.FRSM.a > cc 7
 (session redirected)
mgx8850a.1.7.PXM.a > dspcons
This End        Node Name       Other End       Status
10.1.0.1100     mgx8850a        11.10.0.110     OK
11.10.0.110     mgx8850a        10.1.0.1100     OK
```

Verifying the Configuration

Enter the **ping** command to verify that you have a good connection.

```
wsw-3620a#ping 10.97.110.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.97.110.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/24/28 ms
```

Note Because the FRSM defaults to no signaling and the routers default to Gang of Four (also known as Cisco LMI), the two devices will not communicate until they both share the same protocol.

Note You must have **encap frame ietf** configured on the router before you can have Frame Relay/ATM Service Interworking.

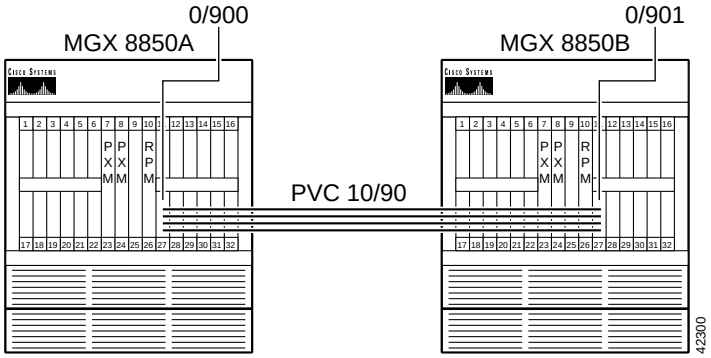
Note The VPI on the RPM switch PVC is always 0.

Note You must match the shaping and policing parameters to prevent data loss.

RPM-to-AUSM-8T1 IMA DAX Connection

For this connection, use the ATM user service module (AUSM)-8T1 card as an Inverse Multiplexing for ATM (IMA) trunk to another AUSM-8T1 card. A connection is built from the RPM on one MGX 8850 to the RPM on the other MGX 8850 across this IMA trunk.

Figure 6-5 RPM-to-AUSM-8T1 IMA DAX Connection



Configuring the AUSM Interface

The following example shows an AUSM interface configuration.

```
/** MGX8850A **/

     mgx8850a.1.27.AUSMB8.a > addln 5
     mgx8850a.1.27.AUSMB8.a > addln 6
     mgx8850a.1.27.AUSMB8.a > addln 7
     mgx8850a.1.27.AUSMB8.a > addln 8

     Syntax : cnfln "line_num line_code line_len clk_src [E1-signaling]"
              line number -- values ranging from 1-8 are accepted, for AUSM-8T1/8E1,
IMATM-T3T1/E3E1
              line code --    2 for B8ZS (T1),
                              3 for HDB3 (E1)
              line length -- 10-15 for T1, 8 for E1 with SMB module,
                              9 for E1 with RJ48 line module
              clock source -- clock source : 1 for loop clock, 2 for local clock
              E1 signaling -- CCS: CCS, no CRC;     CCS_CRC: CCS, with CRC;
                             CLEAR: Clear E1

     mgx8850a.1.27.AUSMB8.a > cnfln 5 2 10 2
     mgx8850a.1.27.AUSMB8.a > cnfln 6 2 10 2
     mgx8850a.1.27.AUSMB8.a > cnfln 7 2 10 2
     mgx8850a.1.27.AUSMB8.a > cnfln 8 2 10 2

     Syntax : addimagrp (or addaimgrp) "group_num port_type list_of_lines  minNumLinks"
              IMA group number -- value ranging from 1 to 8
              Port Type -- 1 - UNI,  2 - NNI
              List of links -- list of links separated by dots
              minimum no of links -- minimum number of links for the group formation
:value ranging from 1 to 8

     mgx8850a.1.27.AUSMB8.a > addimagrp 5 1 5.6.7.8 2

     Syntax : cnfimagrp (or cnfaimgrp) "grp max_diff_delay min_num_links"
              IMA group number -- value ranging from 1 to 8
              Max diff delay -- value between 0 and 275 for AUSM 8T1; btwn 0 and 200 for
AUSM 8E1
              minimum no of links -- minimum number of links for the group formation
:value ranging from 1 to 8

     mgx8850a.1.27.AUSMB8.a > cnfimagrp 5 150 2
```

```
/** MGX8850B **/

mgx8850b.1.27.AUSMB8.a > addln 5
mgx8850b.1.27.AUSMB8.a > addln 6
mgx8850b.1.27.AUSMB8.a > addln 7
mgx8850b.1.27.AUSMB8.a > addln 8

mgx8850b.1.27.AUSMB8.a > cnfln 5 2 10 2
mgx8850b.1.27.AUSMB8.a > cnfln 6 2 10 2
mgx8850b.1.27.AUSMB8.a > cnfln 7 2 10 2
mgx8850b.1.27.AUSMB8.a > cnfln 8 2 10 2

mgx8850b.1.27.AUSMB8.a > addimagrp 6 1 5.6.7.8 2
mgx8850b.1.27.AUSMB8.a > cnfimagrp 6 150 2

mgx8850b.1.27.AUSMB8.a > dspimagrp 6

   IMA Group number                 : 6
   Port type                        : UNI
   Lines configured                 : 5.6.7.8
   Enable                           : Modify
   IMA Port state                   : Active
   IMA Group Ne state               : operational
   PortSpeed (cells/sec)            : 14364
   GroupTxAvailCellRate (cells/sec) : 14364
   ImaGroupTxFrameLength(cells)     : 128
   LcpDelayTolerance (IMA frames)   : 1
   ReadPtrWrPtrDiff  (cells)        : 4
   Minimun number of links          : 2
   MaxTolerableDiffDelay (msec)     : 150
   Lines Present                    : 5.6.7.8
   ImaGroupRxImaId                  : 0x4
   ImaGroupTxImaId                  : 0x5
   Observed Diff delay (msec)       : 0
   Clock Mode                       : CTC
   GroupAlpha                       : 2
   GroupBeta                        : 2
   GroupGamma                       : 1
   GroupConfiguration               : 1
   IMAGrp Failure status            : No Failure
   Timing reference link            : 5
```

Configuring the Router Interface

The following example shows a router interface configuration.

```
/** WSW-8850A-RPM **/

wsw-8850a-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850a-rpm(config)#int sw 1.900 p
wsw-8850a-rpm(config-subif)#ip address 10.97.90.1 255.255.255.0
wsw-8850a-rpm(config-subif)#pvc RPM-IMA_Trunk 0/900
wsw-8850a-rpm(config-if-atm-)#abr 96 64
wsw-8850a-rpm(config-if-atm-)#encap aal5snap
wsw-8850a-rpm(config-if-atm-)#^Z

/** WSW-8850B-RPM **/

wsw-8850b-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850b-rpm(config)#int sw 1.901 p
wsw-8850b-rpm(config-subif)#ip addr 10.97.90.2 255.255.255.0
```

```
wsw-8850b-rpm(config-subif)#pvc RPM-IMA_TRUNK 0/901
wsw-8850b-rpm(config-if-atm-)#abr 96 64
wsw-8850b-rpm(config-if-atm-)#encap aal5snap
wsw-8850b-rpm(config-if-atm-)#^Z
```

Building the RPM-to-AUSM-IMA Slave Connection

The following example shows how to build the RPM to AUSM-IMA slave connection.

```
/** WSW-8850A-RPM **/

wsw-8850a-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850a-rpm(config)#addcon vcc switch 1.900 900 rname mgx8850a rslot 27 5 10 90
wsw-8850a-rpm(config)#^Z

wsw-8850a-rpm#sh sw conn vcc 900
-----------------------------------------------------------
Local Sub-Interface   : 900
Local VPI             : 0
Local VCI             : 900
Remote Node Name      : mgx8850a
Remote Slot           : 27
Remote Interface      : 5
Remote VPI            : 10
Remote VCI            : 90
Routing Priority      : 0
Max Cost              : 255
Restricted Trunk Type : none
Percent Util          : 100
Remote PCR            : 227
Remote MCR            : 151
Remote Percent Util   : 100
Connection Master     : Remote
Synch Status          : inSynch

/** WSW-8850B-RPM **/

wsw-8850b-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850b-rpm(config)#addcon vcc switch 1.901 901 rname mgx8850b rslot 27 6 10 90
wsw-8850b-rpm(config)#^Z
wsw-8850b-rpm#sh sw conn vcc 901
-----------------------------------------------------------
Local Sub-Interface   : 901
Local VPI             : 0
Local VCI             : 901
Remote Node Name      : mgx8850b
Remote Slot           : 27
Remote Interface      : 6
Remote VPI            : 10
Remote VCI            : 90
Routing Priority      : 0
Max Cost              : 255
Restricted Trunk Type : none
Percent Util          : 100
Remote PCR            : 227
Remote MCR            : 151
Remote Percent Util   : 100
Connection Master     : Remote
Synch Status          : inSynch
```

Building the AUSM-IMA-to-AUSM-IMA Trunk Connection

The following example shows how to build the AUSM-IMA to AUSM-IMA trunk connection.

```
/** MGX8850A **/

     Syntax : addcon "port_num vpi vci conn_type service_type [Controller_Type]
[mastership] [remoteConnId] "
              port number -- values ranging from 1-8
              Channel VPI -- Virtual Path Identifier: 0 - 255
              Channel VCI -- Virtual Channel Identifier: 0 - 65535 for VCC, * for VPC
              Connection Type -- Connection Type : 0 - VCC , non zero - Local
                                 VP Id of the VPC (1 to 1000)
              Service Type -- Service Type: 1 - CBR, 2 - VBR, 3 - ABR, 4 - UBR
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              Mastership -- 1 for master, 2 for slave   Default:Slave
              Remote end Connection ID -- Format : NodeName.SlotNo.PortNo.ExternalConnId

     mgx8850a.1.27.AUSMB8.a > addcon 5 10 90 0 3 1 1 mgx8850a.10.1.0.900

     Syntax : cnfupcabr "Port.VPI.VCI enable pcr[0+1] cdvt[0+1] scr scr_police
                        mbs IngPcUtil EgSrvRate EgPcUtil clp_tag "

              Port.VPI.VCI -- A unique Port.VPI.VCI identifying a connection
              Enable/Disable -- UPC : 1 - Disable, 2 - Enable
              PeakCellRate -- PCR [0+1]: 10-PortRate(T1-3622,E1-4528,clearE1-4830),
                      For IMA,T1-3591,E1-4490,clrE1-4789, multiply rate by #links
              CDVT[0+1] -- Cell Delay Variation [0+1]: 1 - 250000 micro_secs
              SCR -- Sustained Cell Rate:10-PortRate(T1-3622,E1-4528,clearE1- 4830),
                      For IMA,T1-3591,E1-4490,ClrE1-4789, multiply rate by #links
              SCR Policing -- 1 - CLP[0] Cells, 2 - CLP[0+1] Cells, 3 - No SCR Policing
              Maximum Burst -- 1 - 5000 cells
              IngPcUtil -- Ingress percentage util: 1 to 127.  0 for default
              EgSrvRate -- Egress service rate:1-PortRate(T1-3622,E1-4528,clearE1-4830)
                      For IMA,T1-3591,E1-4490,clrE1-4789, multiply rate by #links.
              EgPcUtil -- Egress percentage util: 1 to 127.  0 for default
              Clp Tagging -- CLP TAG Enable : 1 - Disable, 2 - Enable

     mgx8850a.1.27.AUSMB8.a > cnfupcabr 5.10.90 2 227 1000 151 2 38 0 227 0 1

     /** MGX8850B **/

     mgx8850b.1.27.AUSMB8.a > addcon 6 10 90 0 3 1 1 mgx8850b.10.1.0.901
     mgx8850b.1.27.AUSMB8.a > cnfupcabr 6.10.90 2 227 1000 151 2 38 0 227 0 1
```

Verifying the Configuration

The following example shows a **ping** from RPM to RPM. In this example, more than 15 cells have gone out. Because this is an available bit rate (ABR) connection, Resource Management cells will be present on the link.

```
/** WSW-8850A-RPM **/

     wsw-8850a-rpm#ping 10.97.90.2

     Type escape sequence to abort.
     Sending 5, 100-byte ICMP Echos to 10.97.90.2, timeout is 2 seconds:
     !!!!!
     Success rate is 100 percent (5/5), round-trip min/avg/max = 20/25/32 ms

     /** MGX8850A **/
```

```
mgx8850a.1.27.AUSMB8.a > dspchancnt 5.10.90

  ChanNum:                                    18
  ChannelState:                               Active
  ChannelEgressRcvState:                      Normal
  ChannelEgressXmitState:                     Normal
  ChannelIngressRcvState:                     Normal
  ChannelIngressXmtState:                     Normal
  ChanInServiceSeconds:                       534
  ChanIngressPeakQDepth(cells):               1
  ChanIngressReceiveCells:                    17
  ChanIngressClpSetCells:                     0
  ChanIngressEfciSetRcvCells:                 0
  ChanIngressEfciSetXmtCells:                 0
  ChanIngressUpcClpSetCells:                  0
  ChanIngressQfullDiscardCells:               0
  ChanIngressClpSetDiscardCells:              0
  ChanIngressTransmitCells:                   17
  ChanShelfAlarmDiscardCells:                 0
  ChanEarlyPacketDiscardCells:                0
  ChanPartialPacketDiscardCells:              0
  ChanIngressTransmitAAL5Frames:              5
  ChanIngressReceiveCellRate(cells/sec):      0
  ChanIngressReceiveUtilization(percentage):  0
  ChanIngressTransmitCellRate(cells/sec):     0
  ChanIngressTransmitUtilization(percentage): 0
  ChanEgressReceiveCellRate(cells/sec):       0
  ChanEgressReceiveUtilization(percentage):   0
  ChanEgressPortQFullDiscardCells:            0
  ChanEgressPortQClpThreshDiscardCells:       0
  ChanTransmitFifoFullCount (per card):       0

/** MGX8850B **/

mgx8850b.1.27.AUSMB8.a > dspchancnt 6.10.90

  ChanNum:                                    27
  ChannelState:                               Active
  ChannelEgressRcvState:                      Normal
  ChannelEgressXmitState:                     Normal
  ChannelIngressRcvState:                     Normal
  ChannelIngressXmtState:                     Normal
  ChanInServiceSeconds:                       184
  ChanIngressPeakQDepth(cells):               1
  ChanIngressReceiveCells:                    17
  ChanIngressClpSetCells:                     0
  ChanIngressEfciSetRcvCells:                 0
  ChanIngressEfciSetXmtCells:                 0
  ChanIngressUpcClpSetCells:                  0
  ChanIngressQfullDiscardCells:               0
  ChanIngressClpSetDiscardCells:              0
  ChanIngressTransmitCells:                   17
  ChanShelfAlarmDiscardCells:                 0
  ChanEarlyPacketDiscardCells:                0
  ChanPartialPacketDiscardCells:              0
  ChanIngressTransmitAAL5Frames:              5
  ChanIngressReceiveCellRate(cells/sec):      0
  ChanIngressReceiveUtilization(percentage):  0
  ChanIngressTransmitCellRate(cells/sec):     0
  ChanIngressTransmitUtilization(percentage): 0
  ChanEgressReceiveCellRate(cells/sec):       0
  ChanEgressReceiveUtilization(percentage):   0
  ChanEgressPortQFullDiscardCells:            0
  ChanEgressPortQClpThreshDiscardCells:       0
```

```
        ChanTransmitFifoFullCount (per card):       0

     /** WSW-8850B-RPM **/

     wsw-8850b-rpm#deb ip pack det
     IP packet debugging is on (detailed)
     *Jan  4 21:26:45.636: IP: s=10.97.90.1 (Switch1.901), d=10.97.90.2 (Switch1.901), len
100, rcvd 3
     *Jan  4 21:26:45.636:     ICMP TYPE=8, code=0
     *Jan  4 21:26:45.636:
     *Jan  4 21:26:45.636: IP: s=10.97.90.2 (local), d=10.97.90.1 (Switch1.901), len 100,
sending
     *Jan  4 21:26:45.636:     ICMP TYPE=0, code=0
     *Jan  4 21:26:45.636:
     *Jan  4 21:26:45.660: IP: s=10.97.90.1 (Switch1.901), d=10.97.90.2 (Switch1.901), len
100, rcvd 3
     *Jan  4 21:26:45.660:     ICMP TYPE=8, code=0
     *Jan  4 21:26:45.660:
     *Jan  4 21:26:45.660: IP: s=10.97.90.2 (local), d=10.97.90.1 (Switch1.901), len 100,
sending
     *Jan  4 21:26:45.660:     ICMP TYPE=0, code=0
     *Jan  4 21:26:45.660:
```

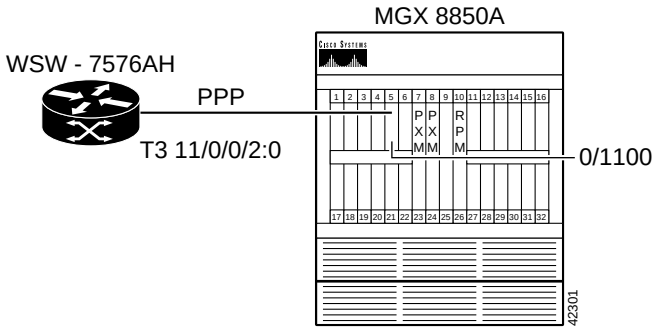
Note The VPI on the RPM switch PVC is always 0.

Note Remember to set the usage parameter control (UPC) on all AUSM connections or the data might not be correctly policed.

RPM-to-FRSM-2CT3 ATM/PPP DAX Connection

In the following example, a Cisco 7576 router transmits IPX datagrams out of a channelized DS3 port adapter using PPP encapsulation. The PPP frames are received on an FRSM-2CT3 service module that uses a frame forwarding connection to convert the frames to ATM cells. The cells are received by the RPM on the switch interface, and the datagrams are reintegrated through the aal5ciscoppp encapsulation.

Figure 6-6 RPM-to-FRSM-2CT3 ATM/PPP DAX Connection



Configuring the FRSM-2CT3 Interface

The following example shows how to configure the FRSM-2CT3 interface.

```
mgx8850b.1.5.VHS2CT3.a > addln 1

     Syntax : cnfln "line_num line_type clk_src "
              DS1 line number -- value range from 1 to 56
              DS1 line type -- 1 = dsx1ESF 2 = dsx1D4
              clock source -- clock source : 1 for loop clock, 2 for local clock

     mgx8850b.1.5.VHS2CT3.a > cnfln 2 1 2

     Syntax : addport "port_num line_num ds0_speed begin_slot num_slot port_ type"
              port number -- values ranging from 1-2( 2T3/2E3/HS2), 1-256 (2CT3)
              port line number -- value ranging from 1 to 56
              DS0 speed -- 1 for 56K,  2 for 64K
              beginning slot -- beginning time slot in 1 base
              number of slot -- number of DS0 time slots assigned to
              port type -- values 1-3, 1=frame relay, 2=FUNI mode-1a, 3=frForward

     mgx8850b.1.5.VHS2CT3.a > addport 20 2 2 1 12 3
```

Configuring the RPM Interface

The following example shows how to configure the RPM interface.

```
wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#ipx routing
     wsw-8850b-rpm(config)#ipx internal DD0000
     wsw-8850b-rpm(config)#username wsw-7576ah pass cisco
     wsw-8850b-rpm(config)#int virtual-Template 1
     wsw-8850b-rpm(config-if)#ipx ipxwan
     wsw-8850b-rpm(config-if)#ppp auth chap
     wsw-8850b-rpm(config-if)#int sw 1.1100 p
     wsw-8850b-rpm(config-subif)#pvc PPP-ATM-FRSM 0/1100
     wsw-8850b-rpm(config-if-atm-)#encap aal5ciscoppp  virtual-Template 1
     wsw-8850b-rpm(config-if-atm-)#vbr-nrt 768 512 600
     wsw-8850b-rpm(config-if-atm-)#^Z
```

Configuring the Router Interface

The following example shows how to configure the router interface.

```
wss-7576ah#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wss-7576ah(config)#ipx routing
     wss-7576ah(config)#ipx internal AB0000
     wss-7576ah(config)#controller T3 11/0/0
     wss-7576ah(config-controller)#t1 2 channel-group 0 timeslots 1-12 speed 64
     wss-7576ah(config-controller)#t1 2 fram esf
     wss-7576ah(config-controller)#t1 2 clock source line
     wss-7576ah(config-controller)#int s 11/0/0/2:0
     wss-7576ah(config-if)#encap ppp
     wss-7576ah(config-if)#ipx ipxwan
     wss-7576ah(config-if)#ppp auth chap
     wss-7576ah(config-if)#username wsw-8850b-rpm pass cisco
     wss-7576ah(config)#^Z
```

Building the FRSM-2CT3 Slave Connection

The following example shows how to build the FRSM-2CT3 slave connection.

```
Syntax : addcon "port dlci cir chan_type serv_type [CAC] [Controller_Type] [mastership]
[remoteConnId]"
              port number -- values ranging from 1-2( 2T3/2E3/HS2), 1-256 (2CT3)
              DLCI number -- value ranging from 0-1023(2CT3/2T3/2E3/HS2)
              committed rate -- 0-1536000 bps for 2CT3; 0-44210000 bps for 2T3;
                              0-34010000 bps for 2E3 , 0-51840000 bps for HS2
              chan type -- values 1-5, 1=NIW 2=SIW-transparent 3=SIW-xlation
                              4=FUNI 5=frForward
              Egress service type --  1 = highpriorityQ      2 = rtVBRQ
                                      3 = nrtVBRQ     4 = aBRQ
                                      5 = uBRQ
              CAC -- Connection Admission Control (optional); 1 = enable, 2 = disable
(default)
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              mastership -- 1 for master, 2 for slave
              Remote end Connection ID -- Format :
               NodeName.SlotNo.PortNo.Dlci OR
               NodeName.SlotNo.PortNo.ControllerId.Dlci for FR end point OR
               NodeName.SlotNo.PortNo.VPI.VCI for ATM end point.
               Where controller ID can be 1(PAR),2(PNNI),3(TAG)

     mgx8850b.1.5.VHS2CT3.a > addcon 20 200 512000 5 3 2 1 2

     Local Connection Id is : mgx8850b.5.20.0.1000
```

Building the RPM Connection

The following example shows how to build the RPM connection.

```
wsw-8850b-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850b-rpm(config)#addcon vcc sw 1.1100 1100 rname mgx8850b rslot 5 20 0 1000 master
local
wsw-8850b-rpm(config-if-atm-)#^Z
```

Verifying the Configuration

Enter the **show ipx route** command to view the contents of the IPX routing table and then enter the **ping** command to verify that you have a good connection, as shown in the following example.

```
wsw-8850b-rpm#sh ipx route
     Codes: C - Connected primary network,    c - Connected secondary network
            S - Static, F - Floating static, L - Local (internal), W - IPXWAN
            R - RIP, E - EIGRP, N - NLSP, X - External, A - Aggregate
            s - seconds, u - uses, U - Per-user static

     2 Total IPX routes. Up to 1 parallel paths and 16 hops allowed.

     No default route known.

     L     DD0000 is the internal network
     R     AB0000 [07/01] via        0.00ab.0000.0000,   27s, Vi1

     wsw-8850b-rpm#ping ipx ab0000.0000.0000.0001

     Type escape sequence to abort.
     Sending 5, 100-byte IPXcisco Echoes to AB0000.0000.0000.0001, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms
```

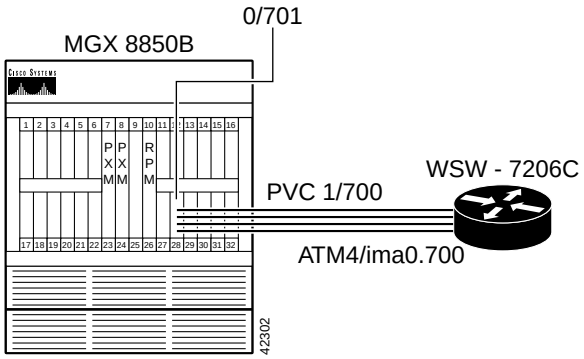
Note The VPI on the RPM switch PVC is always 0.

Note Virtual Template/Interface and the **aal5ciscoppp encap** command are necessary for this configuration.

RPM-to-AUSM-8T1 ATM-IMA DAX Connection

The example below shows an IP connection between an RPM blade and a Cisco 7200 (see Figure 6-7). The Cisco 7200 hooks into the MGX 8850 through an IMA Port Adapter (PA) connected through four T1 lines to the AUSM-8T1 card in slot 28.

Figure 6-7 RPM-to-AUSM-8T1 ATM-IMA DAX Connection



Configuring the AUSM Interface

The following example shows how to configure the AUSM interface.

```
mgx8850b.1.28.AUSMB8.a > addln 5
mgx8850b.1.28.AUSMB8.a > addln 6
mgx8850b.1.28.AUSMB8.a > addln 7
mgx8850b.1.28.AUSMB8.a > addln 8

Syntax : cnfln "line_num line_code line_len clk_src [E1-signaling]"
         line number -- values ranging from 1-8 are accepted, for AUSM-8T1/8E1,
IMATM-T3T1/E3E1
         line code --    2 for B8ZS (T1),
                         3 for HDB3 (E1)
         line length -- 10-15 for T1, 8 for E1 with SMB module,
                         9 for E1 with RJ48 line module
         clock source -- clock source : 1 for loop clock, 2 for local clock
         E1 signaling -- CCS: CCS, no CRC;     CCS_CRC: CCS, with CRC;
                        CLEAR: Clear E1

mgx8850b.1.28.AUSMB8.a > cnfln 5 2 10 2
mgx8850b.1.28.AUSMB8.a > cnfln 6 2 10 2
mgx8850b.1.28.AUSMB8.a > cnfln 7 2 10 2
mgx8850b.1.28.AUSMB8.a > cnfln 8 2 10 2
```

```
     Syntax : addimagrp (or addaimgrp) "group_num port_type list_of_lines  minNumLinks"
              IMA group number -- value ranging from 1 to 8
              Port Type -- 1 - UNI,  2 - NNI
              List of links -- list of links separated by dots
              minimum no of links -- minimum number of links for the group formation
:value ranging from 1 to 8

     mgx8850b.1.28.AUSMB8.a > addimagrp 1 1 5.6.7.8 2
     mgx8850b.1.28.AUSMB8.a > dspaimgrp 1

        IMA Group number                : 1
        Port type                       : UNI
        Lines configured                : 5.6.7.8
        Enable                          : Enabled
        IMA Port state                  : Active
        IMA Group Ne state              : operational
        PortSpeed (cells/sec)           : 14364
        GroupTxAvailCellRate (cells/sec) : 14364
        ImaGroupTxFrameLength(cells)    : 128
        LcpDelayTolerance (IMA frames)  : 1
        ReadPtrWrPtrDiff  (cells)       : 4
        Minimun number of links         : 2
        MaxTolerableDiffDelay (msec)    : 275
        Lines Present                   : 5.6.7.8
        ImaGroupRxImaId                 : 0x0
        ImaGroupTxImaId                 : 0x0
        Observed Diff delay (msec)      : 0
        Clock Mode                      : CTC
        GroupAlpha                      : 2
        GroupBeta                       : 2
        GroupGamma                      : 1
        GroupConfiguration              : 1
        IMAGrp Failure status           : No Failure
        Timing reference link           : 5
```

Configuring the Cisco 7200 Router Interface

The following example shows how configure the layer 1 parameters for the IMA bundle on the Cisco 7200, create the IMA interface, and add the layer 3 addressing.

```
wsw-7206c#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-7206c(config)#int atm 4/0
     wsw-7206c(config-if)#fram esf
     wsw-7206c(config-if)#line b8
     wsw-7206c(config-if)#clock source line
     wsw-7206c(config-if)#lbo short 133
     wsw-7206c(config-if)#ima 0
     wsw-7206c(config-if)#int atm 4/1
     wsw-7206c(config-if)#fram esf
     wsw-7206c(config-if)#line b8
     wsw-7206c(config-if)#clock source line
     wsw-7206c(config-if)#lbo short 133
     wsw-7206c(config-if)#ima 0
     wsw-7206c(config-if)#int atm 4/2
     wsw-7206c(config-if)#fram esf
     wsw-7206c(config-if)#line b8
     wsw-7206c(config-if)#clock source line
     wsw-7206c(config-if)#lbo short 133
     wsw-7206c(config-if)#ima 0
     wsw-7206c(config-if)#int atm 4/3
```

```
wsw-7206c(config-if)#fram esf
wsw-7206c(config-if)#line b8
wsw-7206c(config-if)#clock source line
wsw-7206c(config-if)#lbo short 133
wsw-7206c(config-if)#ima 0
wsw-7206c(config-if)#int atm 4/ima0
wsw-7206c(config-if)#ima active-links-minimum 2
wsw-7206c(config-if)#ima clock comm 0
wsw-7206c(config-if)#ima diff 125
wsw-7206c(config-if)#int atm4/ima0.700 p
wsw-7206c(config-subif)#ip address 10.97.70.1 255.255.255.0
wsw-7206c(config-subif)#pvc WSW-8850B-RPM 1/700
wsw-7206c(config-if-atm-vc)#encap aal5snap
wsw-7206c(config-if-atm-vc)#vbr-nrt 128 96 38
wsw-7206c(config-if-atm-vc)#int atm 4/0
wsw-7206c(config-if)#no shut
wsw-7206c(config-if)#int atm 4/1
wsw-7206c(config-if)#no shut
wsw-7206c(config-if)#int atm 4/2
wsw-7206c(config-if)#no shut
wsw-7206c(config-if)#int atm 4/3
wsw-7206c(config-if)#no shut
wsw-7206c(config-if)#^Z
```

Configuring the RPM Interface

The following example shows how to configure the RPM interface.

```
wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#int sw 1.701 p
     wsw-8850b-rpm(config-subif)#ip addr 10.97.70.2 255.255.255.0
     wsw-8850b-rpm(config-subif)#PVC WSW-7206C-IMA 0/701
     wsw-8850b-rpm(config-if-atm-)#encapsulation aal5snap
     wsw-8850b-rpm(config-if-atm-)#vbr-nrt 128 96 38
     wsw-8850b-rpm(config-if-atm-)#exit
     wsw-8850b-rpm(config-subif)#^Z
```

Building the AUSM Slave Connection

The following example shows how to build the AUSM slave connection.

```
Syntax : addcon "port_num vpi vci conn_type service_type [Controller_Type] [mastership]
[remoteConnId]

              port number -- values ranging from 1-8
              Channel VPI -- Virtual Path Identifier: 0 - 255
              Channel VCI -- Virtual Channel Identifier: 0 - 65535 for VCC, * for VPC
              Connection Type -- Connection Type : 0 - VCC , non zero - Local
                                 VP Id of the VPC (1 to 1000)
              Service Type -- Service Type: 1 - CBR, 2 - VBR, 3 - ABR, 4 - UBR
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              Mastership -- 1 for master, 2 for slave   Default:Slave
              Remote end Connection ID -- Format : NodeName.SlotNo.PortNo.ExternalConnId

     mgx8850b.1.28.AUSMB8.a > addcon 1 1 700 0 2 1 2
     Local Connection Id is : mgx8850b.28.1.1.700

     Syntax : cnfupcvbr "Port.VPI.VCI enable pcr[0+1] cdvt[0+1] scr scr_police
                        mbs IngPcUtil EgSrvRate EgPcUtil clp_tag "

              Port.VPI.VCI -- A unique Port.VPI.VCI identifying a connection
```

```
                Enable/Disable -- UPC : 1 - Disable, 2 - Enable
                PeakCellRate -- PCR [0+1]: 10-PortRate(T1-3622,E1-4528,clearE1-4830),
                        For IMA,T1-3591,E1-4490,clrE1-4789, multiply rate by #links
                CDVT[0+1] -- Cell Delay Variation [0+1]: 1 - 250000 micro_secs
                SCR -- Sustained Cell Rate:10-PortRate(T1-3622,E1-4528,clearE1- 4830),
                        For IMA,T1-3591,E1-4490,ClrE1-4789, multiply rate by #links
                SCR Policing -- 1 - CLP[0] Cells, 2 - CLP[0+1] Cells, 3 - No SCR Policing
                Maximum Burst -- 1 - 5000 cells
                IngPcUtil -- Ingress percentage util: 1 to 127.  0 for default
                EgSrvRate -- Egress service rate:1-PortRate(T1-3622,E1-4528,clearE1-4830)
                        For IMA,T1-3591,E1-4490,clrE1-4789, multiply rate by #links.
                EgPcUtil -- Egress percentage util: 1 to 127.  0 for default
                Clp Tagging -- CLP TAG Enable : 1 - Disable, 2 - Enable

mgx8850b.1.28.AUSMB8.a > cnfupcvbr 1.1.700 2 302 1000 226 2 38 0 302 0 1
```

Now build the RPM Master connection, as shown in the following example.

```
wsw-8850b-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850b-rpm(config)#addcon vcc sw 1.701 701 rname mgx8850b rslot 28 1 1 700 master
local
wsw-8850b-rpm(config)#^Z
```

Verifying the Configuration

Enter the **ping** command to verify that you have a good connection.

```
wsw-8850b-rpm#ping 10.97.70.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.97.70.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/18/20 ms
```

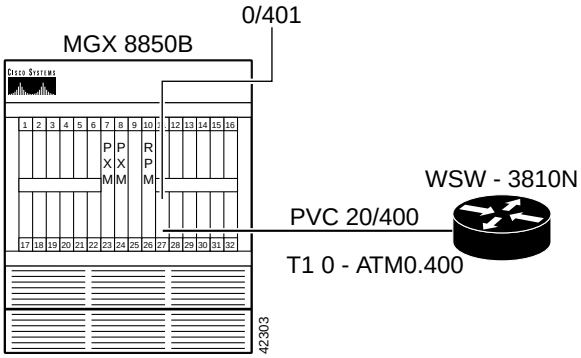
Note Remember to set the UPC parameters on all AUSM connections or your data will most likely not be policed to your needs.

Note The VPI on the RPM switch PVC is always 0.

RPM-to-AUSM-8T1/B ATM/ATM DAX Connection

Establish IP connectivity between a Cisco MC3810 router and the RPM blade on the MGX 8850. In the following example, we have configured the Multi-Flex Trunk (MFT) on the 3810 (Controller T1 0) for ATM (logical interface ATM 0). The MFT is connected to the physical line 1 on the AUSM-8T1/B in slot 27 on the MGX 8850. A DAX connection is built through the PXM to switch cells between the AUSM and the RPM switch interface.

Figure 6-8 RPM-to-AUSM-8T1/B ATM/ATM DAX Connection



Configuring the AUSM Interface

The following example shows how to configure the AUSM interface. To do this, enable the physical line, enable a logical port on the line, adjust parameters as necessary, and enable payload scrambling on the line.

```
mgx8850b.1.27.AUSMB8.a > addln 1
     mgx8850b.1.27.AUSMB8.a > dspln 1

       LineNum:                   1
       LineConnectorType:         RJ-48
       LineType:                  dsx1ESF
       LineEnable:                Enabled
       LineCoding:                dsx1B8ZS
       LineLength:                0-131 ft
       LineXmtClockSource:        LocalTiming
       LineLoopbackCommand:       NoLoop
       LineSendCode:              NoCode
       LineUsedTimeslotsBitMap:   0xffffffff
       LineLoopbackCodeDetection: codeDetectDisabled
       LineBERTEnable:            Disable

     Syntax : addport "port_num port_type line_num"
              port number -- values ranging from 1-8
              Port Type -- 1 - UNI,  2 - NNI
              line number -- value ranging from 1 to 8

     mgx8850b.1.27.AUSMB8.a > addport 1 1 1

     mgx8850b.1.27.AUSMB8.a > dspport 1
     LogicalPortNumber:             1
       Port Enable:                   UP
       Port State:                    Active
       PortType:                      UNI
       PhysicalPortNumber:            1
       CellFraming:                   ATM
       CellScramble:                  No Scramble
       Plpp Loopback:                 No Loopback
       Single-bit error correction:   Disabled

     mgx8850b.1.27.AUSMB8.a > dspplpp 1

       PhysicalPortNumber:            1
       CellFraming:                   ATM
       CellScramble:                  No Scramble
```

```
  Plpp Loopback:                 No Loopback
  Single-bit error correction:   Disabled

Syntax : cnfplpp "phy_port_num loopback scramble singlebit_errcorr_ena"
         physical port number -- value should be between 1 to 8
         plpp loopback -- : 1- no loopback, 2- remote loopback, 3- local loopback
         cell scramble -- cell scramble: 1: no scramble, 2: scramble
         single bit errcorr -- 1: disable, 2: enable
mgx8850b.1.27.AUSMB8.a > cnfplpp 1 1 2 1
```

Configuring the Router Interface

The following example shows how to configure the router interface. To do this, be sure to supply the appropriate physical, data-link, and network layer parameters. Because this is a Cisco 3810 with MFT and digital voice module (DVM), be sure to set the proper clocking from the interface that connects to the AUSM (controller T1 0). Also, be sure to configure the ATM interface for payload scrambling.

```
wsw-3810n#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-3810n(config)#network-clock base-rate 64k
     wsw-3810n(config)#network-clock-select 1 t1 0
     wsw-3810n(config)#controller t1 0
     wsw-3810n(config-controller)#framing esf
     wsw-3810n(config-controller)#linecode b8zs
     wsw-3810n(config-controller)#clock source line
     wsw-3810n(config-controller)#mode atm
     *Mar  3 21:41:02.644:      TDMB   channel # 99 Timeslots ( X 48K, . 56K,* 64K, -
skipped)

     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

     wsw-3810n(config-controller)#int atm 0
     wsw-3810n(config-if)#atm enable-payload-scrambling
     wsw-3810n(config-if)#int atm 0.400 point
     wsw-3810n(config-subif)#pvc MGX8850B-AUSM8 20/400
     wsw-3810n(config-if-atm-vc)#ubr 64
     wsw-3810n(config-if-atm-vc)#ip address 10.97.172.1 255.255.255.0
     *Mar  3 21:44:41.893: Service Type: ATM peak rate provisioned UBR
     wsw-3810n(config-if)#exit
     wsw-3810n(config)#interface Loop 0
     wsw-3810n(config-if)#ip address 10.97.175.1 255.255.255.0
     wsw-3810n(config-if)#exit
     wsw-3810n(config)#router ospf 777
     wsw-3810n(config-router)#network 10.97.168.0 0.0.7.255 area 0

     /**
     In order to prevent clock slips, we need to make sure either the MFT or the DVM
clocks the box, not both.
     **/

     wsw-3810n(config-router)#cont t1 1
     wsw-3810n(config-controller)#clock source internal
     wsw-3810n(config-controller)#^Z
```

Configuring the RPM Interface

The following example shows how to configure the RPM switch interface. Because the RPM operates like a PA-A3 on a Cisco 7200 router, it is configured accordingly. The following example also shows how to set the traffic shaping for unspecified bit rate (UBR) at 64000 bps PCR.

```
wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#int sw 1.400 point
     wsw-8850b-rpm(config-subif)#ip addr 10.97.172.2 255.255.255.0

     /**
     The default MTU on the RPM is 4470 which will cause OSPF fits if we try to establish
a connection to
     a 3810 ATM interface with an MTU of 1500.
     **/

     wsw-8850b-rpm(config-subif)#ip mtu 1500
     wsw-8850b-rpm(config-subif)#pvc WSW-3810N 0/401
     wsw-8850b-rpm(config-if-atm-)#ubr 64
     wsw-8850b-rpm(config-if-atm-)#router ospf 777
     wsw-8850b-rpm(config-router)#network 10.97.168.0 0.0.7.255 area 0
     wsw-8850b-rpm(config-router)#int loop 0
     wsw-8850b-rpm(config-if)#ip addr 10.97.174.1 255.255.255.0
     wsw-8850b-rpm(config-if)#^Z
```

Building the AUSM Slave Connection

The following example shows how to build the AUSM slave connection.

```
Syntax : addcon "port_num vpi vci conn_type service_type [Controller_Type] [mastership]
[remoteConnId]"
              port number -- values ranging from 1-8
              Channel VPI -- Virtual Path Identifier: 0 - 255
              Channel VCI -- Virtual Channel Identifier: 0 - 65535 for VCC, * for VPC
              Connection Type -- Connection Type : 0 - VCC , non zero - Local
                                 VP Id of the VPC (1 to 1000)
              Service Type -- Service Type: 1 - CBR, 2 - VBR, 3 - ABR, 4 - UBR
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              Mastership -- 1 for master, 2 for slave   Default:Slave
              Remote end Connection ID -- Format : NodeName.SlotNo.PortNo.ExternalConnId

     mgx8850b.1.27.AUSMB8.a > addcon 1 20 400 0 4 1 2
     Local Connection Id is : mgx8850b.27.1.20.400

     Syntax : cnfupcubr "Port.VPI.VCI  enable  pcr[0+1]  cdvt[0+1] IngPcUtil clp_tag "
              Port.VPI.VCI -- A unique Port.VPI.VCI identifying a connection
              Enable/Disable -- UPC : 1 - Disable, 2 - Enable
              PeakCellRate -- PCR [0+1]: 10-PortRate(T1-3622,E1-4528,clearE1-4830),
                      For IMA,T1-3591,E1-4490,clrE1-4789, multiply rate by #links
              CDVT[0+1] -- Cell Delay Variation [0+1]: 1 - 250000 micro_secs
              IngPcUtil -- Ingress percentage util: 1 to 127.  0 for default
              Clp Tagging -- CLP TAG Enable : 1 - Disable, 2 - Enable

     mgx8850b.1.27.AUSMB8.a > cnfupcubr 1.20.400 2 151 10000 0 2

     mgx8850b.1.27.AUSMB8.a > dspcon 1.20.400
       ChanNum:                          17
       RowStatus:                        Mod
       ConnectionType:                   VCC
       ServiceType:                      UBR
       ChanSvcFlag:                      PVC
       PortNum:                          1
       VPI:                              20
       VCI (For VCC):                    400
       Local VPId(for VPC):              0
       EgressQNum:                       4
       IngressQDepth(cells):             1000
       IngressDiscardOption:             CLP hysterisis
```

```
IngressFrameDiscardThreshold       1000
IngressQCLPHigh(cells):            900
IngressQCLPLow(cells):             800
QCLPState:                         LOW
IngressEfciThreshold(cells):       1000

UPCEnable:                         Enabled
PeakCellRate[0+1](cells/sec):      151
CellDelayVariation[0+1]:           10000 (micro secs)
PeakCellRate[0](cells/sec):        3622
CellDelayVariation[0]:             250000 (micro secs)
SustainedCellRate(cells/sec):      151
MaximumBurstSize(cells):           1000
SCRPolicing:                       CLP[0]
CLPTagEnable:                      Enabled
FrameGCRAEnable:                   Disable

ForesightEnable:                   Disable
InitialBurstSize(cells):           0
ForeSightPeakCellRate(cells/sec):  151
MinimumCellRate(cells/sec):        0
InitialCellRate(cells/sec):        0

LocalRemoteLpbkState:              Disable
ChanTestType:                      No Test
ChanTestState:                     Not In Progress
ChanRTDresult:                     65535 ms

Ingress percentage util:           1
Egress percentage util :           0
Egress Service Rate:               0
LocalVpi:                          20
LocalVci:                          400
LocalNSAP:                         6d677838383530620000000000000001b000100
RemoteVpi:                         0
RemoteVci:                         0
RemoteNSAP:                        546869732069732061206475 6d6d79204e534150
Mastership:                        Slave
VpcFlag:                           Vcc
ConnServiceType:                   UBR
RoutingPriority:                   1
MaxCost:                           255
RestrictTrunkType:                 No Restriction
ConnPCR:                           151
ConnMCR:                           0
ConnPercentUtil:                   1
```

Building the RPM Master Connection

The following example shows how to build the RPM master connection.

```
wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#addcon vcc switch 1.400 401 rname mgx8850b rslot 27 1 20 400
master local
     wsw-8850b-rpm(config)#^Z
     wsw-8850b-rpm#cc 7
      (session redirected)
     mgx8850b.1.7.PXM.a > dspcons
     This End        Node Name       Other End       Status
     10.1.0.401      mgx8850b        27.1.20.400     OK
     27.1.20.400     mgx8850b        10.1.0.401      OK
```

Verifying the Configuration

Enter the **show ip ospf neighbor** command to view the OSPF-neighbor information on a per-interface basis. Then enter the **ping** command to verify that you have a good connection, as shown in the following example.

```
wsw-3810n#sh ip ospf nei

     Neighbor ID     Pri   State           Dead Time   Address         Interface
     10.97.174.1       1   FULL/  -        00:00:34    10.97.172.2     ATM0.400

     wsw-3810n#ping 10.97.172.2

     Type escape sequence to abort.
     Sending 5, 100-byte ICMP Echos to 10.97.172.2, timeout is 2 seconds:
     !!!!!
     Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

Caveats

The following caveats exist.

Note Always check scrambling. Often two ATM devices stop communicating because scrambling is enabled on one device but is disabled on the other.

Note The maximum transmission unit (MTU) sizing default is 4470 on the RPM switch interface and 1500 on the Cisco 3810. A mismatch will cause problems with Open Shortest Path First (OSPF) procedures.

Note On a Cisco 3810 with DVM and MFT, to take the time from the MFT, you must configure the clock source on the DVM to something other than the line; otherwise, clock slips will occur.

Note The VPI on the RPM switch PVC is always 0.

Warning **It is necessary to match the shaping and policing parameters to prevent data loss. It is very easy to forget the CNFUPC*** command on the AUSM.**

RPM-to-PXM Feeder Trunk Connections

In the configuration examples in this section, datagrams enter and leave an RPM, get switched on the local Processor Switching Module (PXM), and leave and enter through a feeder trunk on the PXM. The BPX 8600, attached to the MGX 8850, switches the ATM cells to either another feeder-attached MGX 8850, ATM-attached customer premises equipment (CPE), or a feeder-attached MGX 8220.

RPM-to-RPM Three-Segment Connection

In the following examples, IP connectivity is established between RPM blades on two different MGX 8850 nodes. A connection is configured on each RPM to the feeder trunk on its associated PXM. Then, a connection is built on the BPX to join the feeder segments.

Configuring the RPM Interfaces

The following example shows how to set the traffic shaping for unspecified bit rate (UBR) at 256000 bps peak cell rate (PCR).

```
/** WSW-8850A-RPM **/

     wsw-8850a-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850a-rpm(config)#int switch 1.300 point
     wsw-8850a-rpm(config-subif)#ip addr 10.97.30.1 255.255.255.0
     wsw-8850a-rpm(config-subif)#pvc 8850b-rpm 0/3000
     wsw-8850a-rpm(config-if-atm-)#ubr 256
     wsw-8850a-rpm(config-if-atm-)#^Z

     /** WSW-8850B-RPM **/

     wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#int switch 1.300 point
     wsw-8850b-rpm(config-subif)#ip addr 10.97.30.2 255.255.255.0
     wsw-8850b-rpm(config-subif)#pvc 8850a-rpm 0/3001
     wsw-8850b-rpm(config-if-atm-)#ubr 256
     wsw-8850b-rpm(config-if-atm-)#^Z
```

Adding the RPM-to-Trunk Connections

The following example shows how to add the RPM to trunk connections.

```
/** WSW-8850A-RPM **/

     wsw-8850a-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850a-rpm(config)#addcon vcc sw 1.300 3000 rname mgx8850a rslot 0 1 30 3100
master local
     wsw-8850a-rpm(config)#^Z
     wsw-8850a-rpm#sh switch conn
                                                                          Synch
     lVpi   lVci     remoteNodeName   remoteSlot remoteIf  rVpi   rVci     Status
     0      3000     mgx8850a         0          1         30     3100    inSynch
     wsw-8850a-rpm#sh switch conn vcc 3000
     ----------------------------------------------------------
     Local Sub-Interface   : 300
     Local VPI             : 0
     Local VCI             : 3000
     Remote Node Name      : mgx8850a
     Remote Slot           : 0
     Remote Interface      : 1
     Remote VPI            : 30
     Remote VCI            : 3100
     Routing Priority      : 0
     Max Cost              : 255
     Restricted Trunk Type : none
     Percent Util          : 100
```

```
     Remote PCR            : 604
     Remote MCR            : 604
     Remote Percent Util   : 100
     Connection Master     : Local
     Synch Status          : inSynch

     /** Since we have not built the BPX connection, our RPM-PXM connection will
     have A-Bit issues **/

     wsw-8850a-rpm#cc 7
     (session redirected)
     mgx8850a.1.7.PXM.a > dspcons
     This End        Node Name       Other End       Status

     7.1.30.3100     mgx8850a        10.1.0.3000     FAILED  ABIT ALARM
     10.1.0.3000     mgx8850a        7.1.30.3100     FAILED  ABIT ALARM

     /** WSW-8850B-RPM **/

     wsw-8850b-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850b-rpm(config)#addcon vcc sw 1.300 3001 rname mgx8850b rslot 0 1 31 3101
master local
     wsw-8850b-rpm(config)#^Z
     wsw-8850b-rpm#sh swit con
                                                                          Synch
     lVpi   lVci     remoteNodeName   remoteSlot remoteIf  rVpi   rVci     Status

     0      3001     mgx8850b         0          1         31     3101    inSynch
     wsw-8850b-rpm#sh sw conn vcc 3001
     -------------------------------------------------------
     Local Sub-Interface   : 300
     Local VPI             : 0
     Local VCI             : 3001
     Remote Node Name      : mgx8850b
     Remote Slot           : 0
     Remote Interface      : 1
     Remote VPI            : 31
     Remote VCI            : 3101
     Routing Priority      : 0
     Max Cost              : 255
     Restricted Trunk Type : none
     Percent Util          : 100
     Remote PCR            : 604
     Remote MCR            : 604
     Remote Percent Util   : 100
     Connection Master     : Local
     Synch Status          : inSynch

     wsw-8850b-rpm#cc 7
     (session redirected)
     mgx8850b.1.7.PXM.a > dspcons
     This End        Node Name       Other End       Status
     7.1.31.3101     mgx8850b        10.1.0.3001     FAILED  ABIT ALARM
     10.1.0.3001     mgx8850b        7.1.31.3101     FAILED  ABIT ALARM
```

Adding the Trunk-to-Trunk Connection

The following example shows how to add a trunk-to-trunk connection, including the commands that must be entered to create this connection.

```
wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    July 29 1999 16:09 EDT

      From            Remote      Remote                              Route
      11.1.30.3100    NodeName    Channel         State  Type        Avoid COS O
      11.1.30.3100    wsw-bpx3    9.1.31.3101     Ok     ubr

     Last Command: addcon 11.1.30.3100 wsw-bpx3 9.1.31.3101 ubr 604 * 5000 * *

     wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    July 29 1999 16:09 EDT

     Conn:  11.1.30.3100     wsw-bpx3    9.1.31.3101       ubr       Status:OK
         PCR(0+1)    % Util    CDVT(0+1)    FBTC CLP Set
         604/604      1/1      5000/5000     y     1


     Path:   Route information not applicable for local connections
     wsw-bpx3      BXM       : OK           wsw-bpx3  BXM       : OK
                   Line 11.1 : OK                     Line  9.1 : OK
                   OAM Cell RX: Clear                 NNI       : OK
                   NNI       : OK

     This Command: dspcon 11.1.30.3100
```

Verifying the Configuration

Enter the **ping** command to verify that you have a good connection, as shown in the following example.

```
/** Ping from RPM to RPM **/

     wsw-8850a-rpm#ping 10.97.30.2

     Type escape sequence to abort.
     Sending 5, 100-byte ICMP Echos to 10.97.30.2, timeout is 2 seconds:
     !!!!!
     Success rate is 100 percent (5/5), round-trip min/avg/max = 8/11/12 ms

     /** Examine Channel Stats on BPX **/

     wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    July 29 1999 16:11 EDT

     Channel Statistics for 11.1.30.3100Cleared: July 29 1999 16:11  (-)  Snapshot
     PCR: 604/604 cps        Collection Time: 0 day(s) 00:00:13      Corrupted: NO
        Traffic      Cells      CLP      Avg CPS   %util  Chan Stat Addr: 30F68D4C
     From Port   :      2686          0      205      33  OAM Cell RX: Clear
     To Network  :      2686    ---          205      33
     From Network:      2699          0      206      34
     To Port     :      2699          0      206      34

     Rx Frames Rcv :        29  NonCmplnt Dscd:         0  Rx Q Depth    :         0
     Tx Q Depth    :         0  Rx CLP0       :      2686  Rx Nw CLP0    :      2699
     Igr VSVD ACR  :         0  Egr VSVD ACR  :         0  Tx Clp0 Port  :      2699
     Rx Clp0+1 Port:      2686  NCmp CLP0 Dscd:         0  NCmp CLP1 Dscd:         0
     Oflw CLP0 Dscd:         0  Oflw CLP1 Dscd:         0

     Last Command: dspchstats 11.1.30.3100 1

     /** Show Connections on PXMs - A-Bit alarms Disappear **/

     mgx8850a.1.7.PXM.a > dspcons
     This End        Node Name       Other End       Status

     7.1.30.3100     mgx8850a        10.1.0.3000     OK
     10.1.0.3000     mgx8850a        7.1.30.3100     OK
```

```
mgx8850b.1.7.PXM.a > dspcons
This End        Node Name       Other End       Status

7.1.31.3101     mgx8850b        10.1.0.3001     OK
10.1.0.3001     mgx8850b        7.1.31.3101     OK
```

Note The VPI on the RPM switch PVC is always 0.

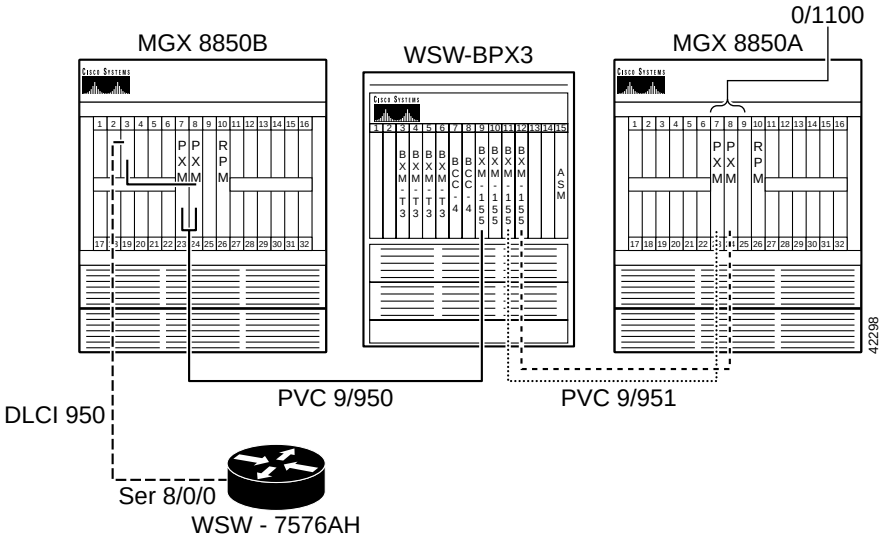
Note Match the shaping and policing parameters on both the MGX and the BPX to prevent data loss.

RPM-to-FRSM-2E3 Three-Segment Connection

The FRSM uses the service interworking translation method to convert incoming Frame Relay frames to ATM cells. The ATM cells are switched out the PXM interface and switched between feeder trunks by the BPX. When the cells are received by the other PXM, they are switched to the switch interface on the RPM in the node where they are re-integrated back into IP datagrams.

In the example below, IP datagrams are transported through Frame Relay/ATM service interworking between a Frame Relay-attached router and an RPM. An unchannelized E3 port adapter is connected on a Cisco 7576 router to line 1 on the Frame Relay Service Module (FRSM-2E3) in slot 3 of one MGX 8850.

Figure 6-9 RPM-to-FRSM-2E3 Three-Segment Connection



Configuring the FRSM-2E3 Interface

The following example shows how to configure the FRSM-2E3 interface.

```
mgx8850b.1.3.VHS2E3.a > addln 1

     Syntax : cnfds3ln "line_num line_len clk_src "
              E3 line number -- value range from 1 to 2
              line length --  1 for LessThan225ft,
                              2 for GreaterThan225ft
              Dsx3 Xmt Clock Src -- 1 : backplane-clk 2 : recovery-clk  3 : Local-clk

     mgx8850b.1.3.VHS2E3.a > cnfds3ln 1 1 1

     Syntax : addport "port_num line_num port_type "
              port number -- values ranging from 1-2( 2T3/2E3/HS2), 1-256 (2CT3)
              port line number -- value ranging from 1 to 2
              port type -- values 1-3, 1=frame relay, 2=FUNI mode-1a, 3=frForward

     mgx8850b.1.3.VHS2E3.a > addport 1 1 1

     Syntax : cnfport "portNum lmiSig asyn ELMI T391 T392 N391 N392 N393"
              port number -- values ranging from 1-2( 2T3/2E3/HS2), 1-256 (2CT3)
              LMI signaling -- (N)one (S)trataLMI au-AnnexAUNI
              du-AnnexDUNI an-AnnexANNI dn-AnnexDNNI
              asyn update --  (UPD = Update Status, UFS = Unsolicited Full Status)
                     (n or 1) = both dis, (y or 2) = UPD en, 3 = UFS en, 4 = both en
              Enhanced LMI -- (N or n) disable (Y or y) enable
              T391 timer -- value ranging from 5 to 30 sec.
              T392 timer -- value ranging from 5 to 30 sec.
              N391 counter -- value ranging from 1 to 255
              N392 counter -- value ranging from 1 to 10
              N393 counter -- value ranging from 1 to 10, greater than N392

     mgx8850b.1.3.VHS2E3.a > cnfport 1 S n n
     mgx8850b.1.3.VHS2E3.a > dspds3ln 1

       LineNum:               1
       LineEnable:            Modify
       LineType:              G.751
       LineCoding:            e3HDB3
       LineLength:            LT225ft
       LineSubRateEnable:     Disable
       LineDsuSelect:         dl3100Mode
       LineRate:              34368kbps
       LineLoopbackCommand:   NoLoop
       LineXmitClockSource:   backplaneClk
       LineEqualizer:         internal equalizer
       LineBertEnable:        Disable

     Syntax : cnflnsubrate " line_num dsu_subrate_ena dsu_select dsu_line_rate "
              E3 line number -- value range from 1 to 2
              ds3 SubRate Enable -- 1 = disable, 2 = enable
              ds3 Dsu Select -- 1 = dl3100Mode, 2 = adcKentroxMode
              dsu Line Rate -- values ranging from 300 to 44736 in steps of 300kbps
(dl3100Mode) or 500 Kbps (adcKentroxMode)

     mgx8850b.1.3.VHS2E3.a > cnflnsubrate 1 2 1 33900
     dsx3LineRate = 33900
```

Configuring the Router Interface

The following example shows how to configure the router interface:

```
wss-7576ah#conf t Enter configuration commands, one per line. End with CNTL/Z.
wss-7576ah(config)#int s 8/0/0
wss-7576ah(config-if)#encap frame ietf wss-7576ah(config-if)#no shut
wss-7576ah(config-if)#clock source line
wss-7576ah(config-if)#dsu band 33900
wss-7576ah(config-if)#int s 8/0/0.950 p
wss-7576ah(config-subif)#ip addr 10.97.95.2 255.255.255.0
wss-7576ah(config-subif)#frame-relay interface-dlci 950
wss-7576ah(config-fr-dlci)#^Z
```

Configuring the RPM Interface

The following example shows how to configure the RPM interface:

```
wsw-8850a-rpm#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
wsw-8850a-rpm(config)#int sw 1.951 p
wsw-8850a-rpm(config-subif)#ip address 10.97.95.1 255.255.255.0
wsw-8850a-rpm(config-subif)#PVC RPM-FRSM2E3 0/951
wsw-8850a-rpm(config-if-atm-)#vbr-nrt 384 256 151
wsw-8850a-rpm(config-if-atm-)#encap aal5snap
wsw-8850a-rpm(config-if-atm-)#^Z
```

Building the FRSM-2E3-to-Trunk Connection

The following example shows how to build the FRSM-2E3 to trunk connection.

```
Syntax : addcon "port dlci cir chan_type serv_type [CAC] [Controller_Type] [mastership]
[remoteConnId] "
              port number -- values ranging from 1-2( 2T3/2E3/HS2), 1-256 (2CT3)
              DLCI number -- value ranging from 0-1023(2CT3/2T3/2E3/HS2)
              committed rate -- 0-1536000 bps for 2CT3; 0-44210000 bps for 2T3;
                              0-34010000 bps for 2E3 , 0-51840000 bps for HS2
              chan type -- values 1-5, 1=NIW 2=SIW-transparent 3=SIW-xlation
                              4=FUNI 5=frForward
              Egress service type --  1 = highpriorityQ      2 = rtVBRQ
                                      3 = nrtVBRQ     4 = aBRQ
                                      5 = uBRQ
              CAC -- Connection Admission Control (optional); 1 = enable, 2 = disable
(default)
              Controller Type (Signaling) -- 1: PVC (PAR) - Default , 2: SPVC (PNNI)
              mastership -- 1 for master, 2 for slave
              Remote end Connection ID -- Format :
               NodeName.SlotNo.PortNo.Dlci OR
               NodeName.SlotNo.PortNo.ControllerId.Dlci for FR end point OR
               NodeName.SlotNo.PortNo.VPI.VCI for ATM end point.
               Where controller ID can be 1(PAR),2(PNNI),3(TAG)

     mgx8850b.1.3.VHS2E3.a > addcon 1 950 256000 3 3 2 1 1 mgx8850b.0.1.9.950
     mgx8850b.1.3.VHS2E3.a > dspchans

         DLCI      Chan ServType   I/EQDepth  I/EQDEThre  I/EECNThre  Fst/ DE Type Alarm
       ---------   ---- --------   ----- ----- ----- ----- ----- ----- --- --- ----- -----
       3.1.1.950      21   nrtVBR 1048575/1048575 524287/524287 104857/104857 Dis/Dis
SIW-X  Yes

     Syntax : cnfchanpol "chan_num cir bc be ibs detag"
              channel number -- value ranging from 16-4015(2CT3), 16-2015( 2T3/2E3/HS2)
              committed rate -- 0-1536000 bps for 2CT3; 0-44210000 2T3;
                              0-34010000 bps for 2E3; 0-51840000 bps for HS2
              committed burst -- 0-2097151 in bytes
              excess burst -- 0-2097151 in bytes
```

```
                initial burst -- 0-2097151 in bytes, Less than or equal to Bc
                DE bit tagging -- 1 for enable, 2 for disable

     mgx8850b.1.3.VHS2E3.a > cnfchanpol 21  256000 32000 16000 8000 2
```

Building the RPM-to-Trunk Connection

The following example shows how to build the RPM to trunk connection:

```
wsw-8850a-rpm#conf t
     Enter configuration commands, one per line.  End with CNTL/Z.
     wsw-8850a-rpm(config)#addcon vcc switch 1.951 951 rname mgx8850a rslot 0 1 9 951
master local
     wsw-8850a-rpm(config)#^Z
```

Building the Trunk-to-Trunk Connection

The following example shows how to configure a trunk-to-trunk connection, including the commands that must be entered to create this connection.

```
wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    Aug. 9 1999  10:09 EDT

      From            Remote      Remote                              Route
      11.1.9.951      NodeName    Channel         State  Type        Avoid COS O
      11.1.9.951      wsw-bpx3    9.1.9.950       Ok     atfr

     Last Command: addcon 11.1.9.951 wsw-bpx3 9.1.9.950 atfr 906 * 1000 604 151 * * * *

     wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    Aug. 9 1999  10:09 EDT

     Conn:  11.1.9.951       wsw-bpx3    9.1.9.950         atfr      Status:OK
        PCR(0+1)        % Util       CDVT(0+1)            SCR               MBS
       906/906         100/100       1000/1000         604/604           151/151

     Policing    VC Qdepth     EFCI         IBS
         3      1280/1280     35/35        1/1

     Path:   Route information not applicable for local connections

     wsw-bpx3      BXM       : OK           wsw-bpx3  BXM       : OK
                   Line 11.1 : OK                     Line  9.1 : OK
                   OAM Cell RX: Clear                 NNI       : OK
                   NNI       : OK

     This Command: dspcon 11.1.9.951
```

Verifying the Configuration

Enter the **ping** command to verify that you have a good connection, as shown in the following example.

```
/** The Ubiquitous Ping Test **/

     wsw-8850a-rpm#ping 10.97.95.2

     Type escape sequence to abort.
     Sending 5, 100-byte ICMP Echos to 10.97.95.2, timeout is 2 seconds:
     !!!!!
     Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms

     /** Examine Channel Stats on BPX **/
```

```
wsw-bpx3       TN    StrataCom       BPX 8620  9.2.10    Aug. 9 1999  10:11 EDT

Channel Statistics for 11.1.9.951  Cleared: Aug. 9 1999  10:11  (-)
PCR: 906/906 cps        Collection Time: 0 day(s) 00:00:06      Corrupted: NO
   Traffic      Cells      CLP      Avg CPS   %util  Chan Stat Addr: 30F6933C
From Port   :        15          0        2       0  OAM Cell RX: Clear
To Network  :        15    ---            2       0
From Network:        15          0        2       0
To Port     :        15          0        2       0

Rx Frames Rcv :         5  NonCmplnt Dscd:         0  Rx Q Depth    :         0
Tx Q Depth    :         0  Rx CLP0       :        15  Rx Nw CLP0    :        15
Igr VSVD ACR  :         0  Egr VSVD ACR  :         0  Tx Clp0 Port  :        15
Rx Clp0+1 Port:        15  NCmp CLP0 Dscd:         0  NCmp CLP1 Dscd:         0
Oflw CLP0 Dscd:         0  Oflw CLP1 Dscd:         0

This Command: dspchstats 11.1.9.951 1
```

Caveats

The following caveats exist.

Note Because the FRSM defaults to no signaling and the routers default to Gang of Four (also known as Cisco LMI), the two devices will not communicate until they both share a protocol.

Note The **encap frame ietf** command is needed on the router for the Frame Relay/ATM Service Interworking.

Note The VPI on the RPM switch PVC is always 0.

Note To prevent data loss, you must match the shaping and policing parameters.

Connection Synchronization

Because connections are added separately to the RPM and to PXM or other RPM cards, connections may exist on the RPM but not on the PXM or the other RPM cards. Therefore, connection synchronization, which is also referred to as service module resynchronization, between the RPM and the other service modules is necessary.

Note This refers to synchronization between the modules' databases, not between the endpoints.

- If connection parameters are mismatched between the two databases, the connection status is set to "MISMATCH." To correct the problem the user is required to delete and re-add the connection.
- Administrative status is not considered as a connection parameter. Therefore, any mismatch in administrative status will not be detected by the connection synchronization feature. The mismatch, however, can be made known by using the OAM loopback test.

- If a connection exists on the RPM but not on a PXM or another RPM, the connection status will be set to “ONLY_ON_RPM.” To correct the problem the user is required to delete and re-add the connection.
- If connection exists on a PXM or another RPM, but not on the local RPM, the connection status will be set to “NOT_ON_RPM.” To correct the problem the user is required to delete and re-add the connection. The connection on the other service module can be deleted by issuing “no switch connection” on the RPM as if the connection exists on the RPM.

Manually Resynchronizing Connections

You can manually resynchronize connections. However, out of synchronization conditions may be triggered by

- Periodic kickoffs
- Connection provisioning time-out on the RPM
- PXM switchover
- RPM reset

You can force resynchronization by entering the **start_resynch** command at the configure interface level as shown here:

```
NY_9# conf t
NY_9(config)# int sw1
NY-9(config-if)#switch start_resynch
```

Automatically Resynchronizing Connections

auto_synch corrects mismatches between the PXM and the RPM databases. If your network is highly unstable, do not turn on **auto_synch**.

The commands that are used to enable/disable the **auto_synch** feature are moved under the new **switch** command. Here is an example of how you use this command on the config level.

```
NY_9# conf t
NY_9(config)# int sw1
NY-9(config-if)#switch auto_synch on <off|manual> “default is off”
```

Connection State Alarms

This section describes the alarm state of each PNNI, how alarms occur, and what they mean.

Endpoint status indicators reported by RPM and their meanings include:

- **egrAisRdi**—The endpoint is receiving AIS or RDI cells in the egress direction (from the network).
- **ccFail**—An OAM loopback failure has occurred.
- **mismatch**—There is a mismatch between the RPM and Connection Manager databases.
- **conditioned—**There is a routing failure.

These alarms are triggered when

- There is a change in the endpoint status.
- If a failure is detected by the Connection Manager during a routine routing status check.

Connection State Resynchronization

Connection state resynchronization is triggered by a PXM-1 switchover or an RPM reset. This happens when an alarm state is not persistent nor contains redundant data, and needs to be rebuilt after a switchover or reset.

Configuring MPLS and VPN

This chapter describes MPLS and VPN features used with the RPM in the MGX 8850 switch and covers the following topics:

- MPLS Overview
- VPN Overview
- How VPNs Work
- Configuring a VPN
- Configuring an ATM PVC for Carrying Packet-Based MPLS
- Configuring a Virtual Path Tunnel
- RPM Configuration Examples for MPLS-based Virtual Private Networks
- Two PE–Three CE Configuration, RIP-connected CE Routers
- Two PE–Three CE Configuration, Static routing to CE Routers
- Support for LDP
- Support for Multi-VC on the RPM-PR

For more information on MPLS, refer to the *Cisco MPLS Controller Software Configuration Guide*. For MPLS and VPN commands, refer to the *Cisco MPLS VPN Feature Guide*.

MPLS Overview

This section describes Multiprotocol Label Switching (MPLS) and the role of the Route Processor Module (RPM) as an Edge Label Switch Router (LSR) within the MGX 8850 switch. It also includes a description of how the RPM, as an Edge LSR, acts as an MPLS “feeder” to the BPX 8650 switch.

The labels used to forward packets are negotiated using Label Distribution Protocol (LDP) or Tag Distribution Protocol (TDP). In this context, the RPM functions as an Edge LSR to receive and label IP packets.

There are two different modes of MPLS operation, and the RPM supports both of them.

- Frame-based
- ATM cell-based

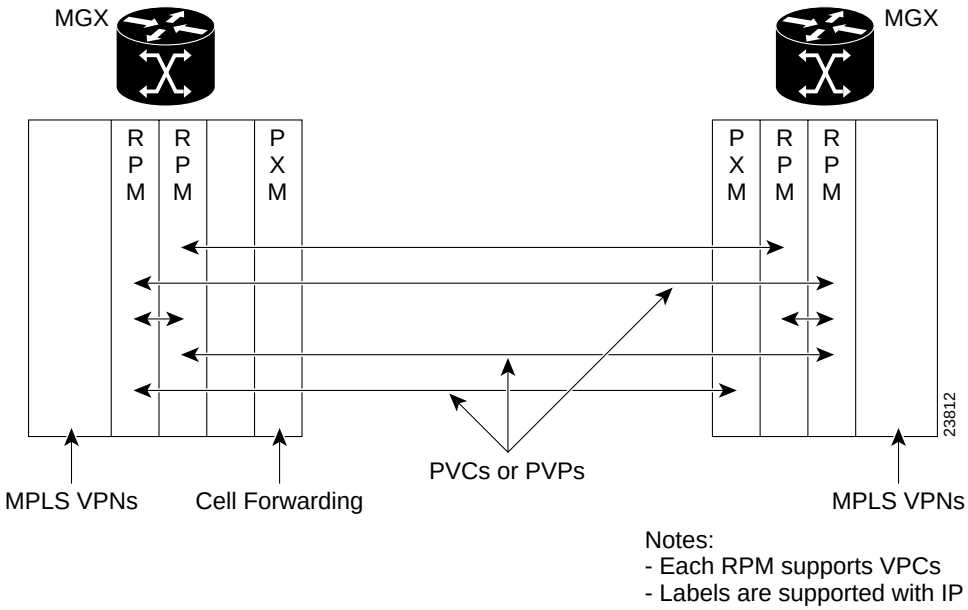
Frame-Based MPLS

In the frame-based mode, all MPLS frames between two MPLS devices move within a single point-to-point channel. MPLS information is carried as a separate header in each frame. The RPM supports frame-based MPLS within permanent virtual circuits (PVCs). There are two typical uses of frame-based MPLS with RPMs.

- It is possible to use RPMs as Edge LSRs linked by PVCs, without using MPLS on the core switches. In this type of network, PVCs are typically used to connect every RPM in a network to every other RPM using a full mesh of PVCs. This setup is illustrated in Figure 7-1.

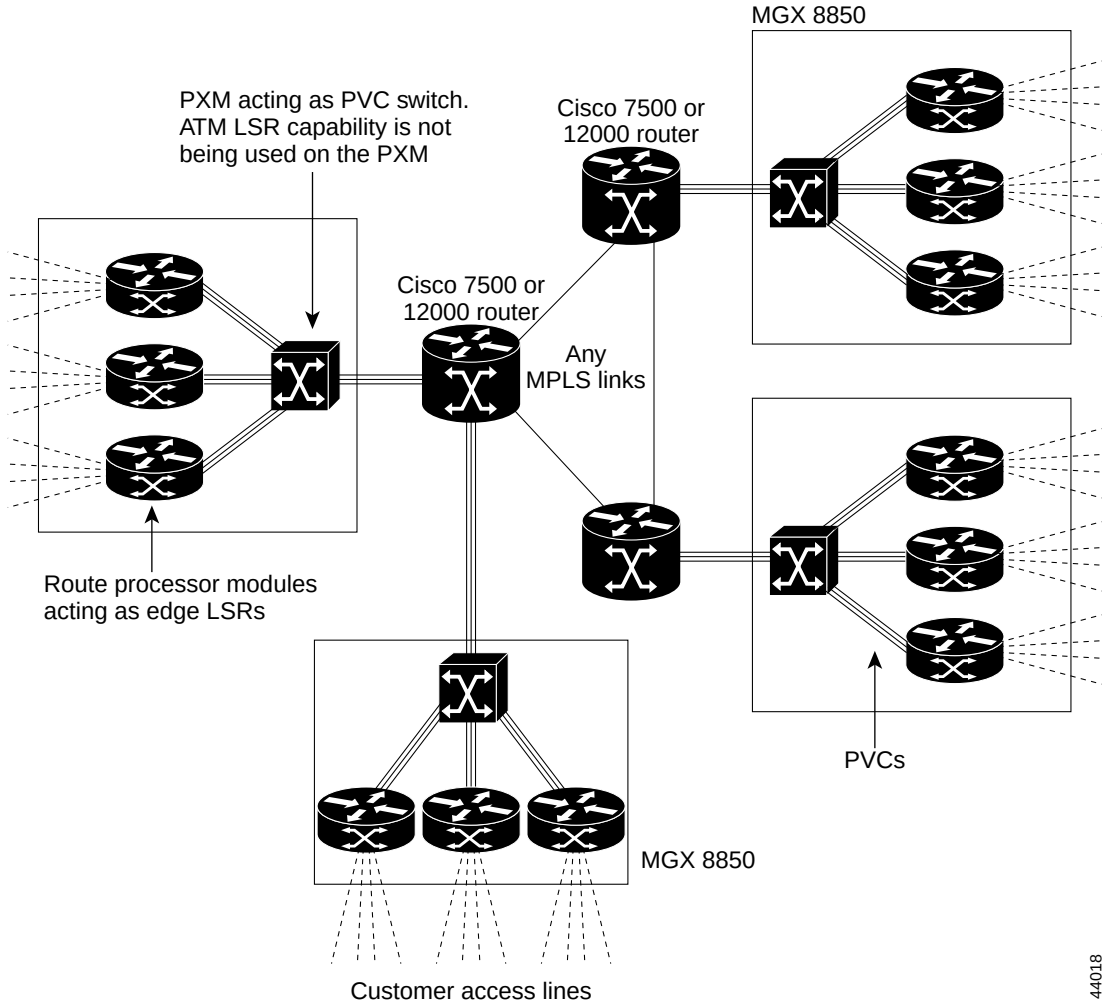
Note Careful network design is required to use fully-meshed networks with more than about 30 Edge LSRs. Contact TAC if you need assistance.

Figure 7-1 MPLS for the MGX 8850 in a Fully-Meshed PVC or PVP Configuration



- PVCs running packet-based MPLS can also be used to connect RPMs to other Cisco packet-based MPLS devices, such as Cisco 7500-series or 12000-series routers. In such a network, the RPMs would typically act as Edge LSRs, and the other routers as (core) LSRs. This setup is illustrated in Figure 7-2.

Figure 7-2 MPLS for the MGX 8850 with a Router Network Core



The RPM also supports packet-based MPLS over its Ethernet and Fast Ethernet port adaptors.

ATM MPLS

Numerous VCs, known as MPLS Label VCs (LVCs), are used to connect a pair of ATM MPLS devices. The LVCs are established under the direct control of MPLS signaling, and each LVC corresponds to a distinct MPLS label value.

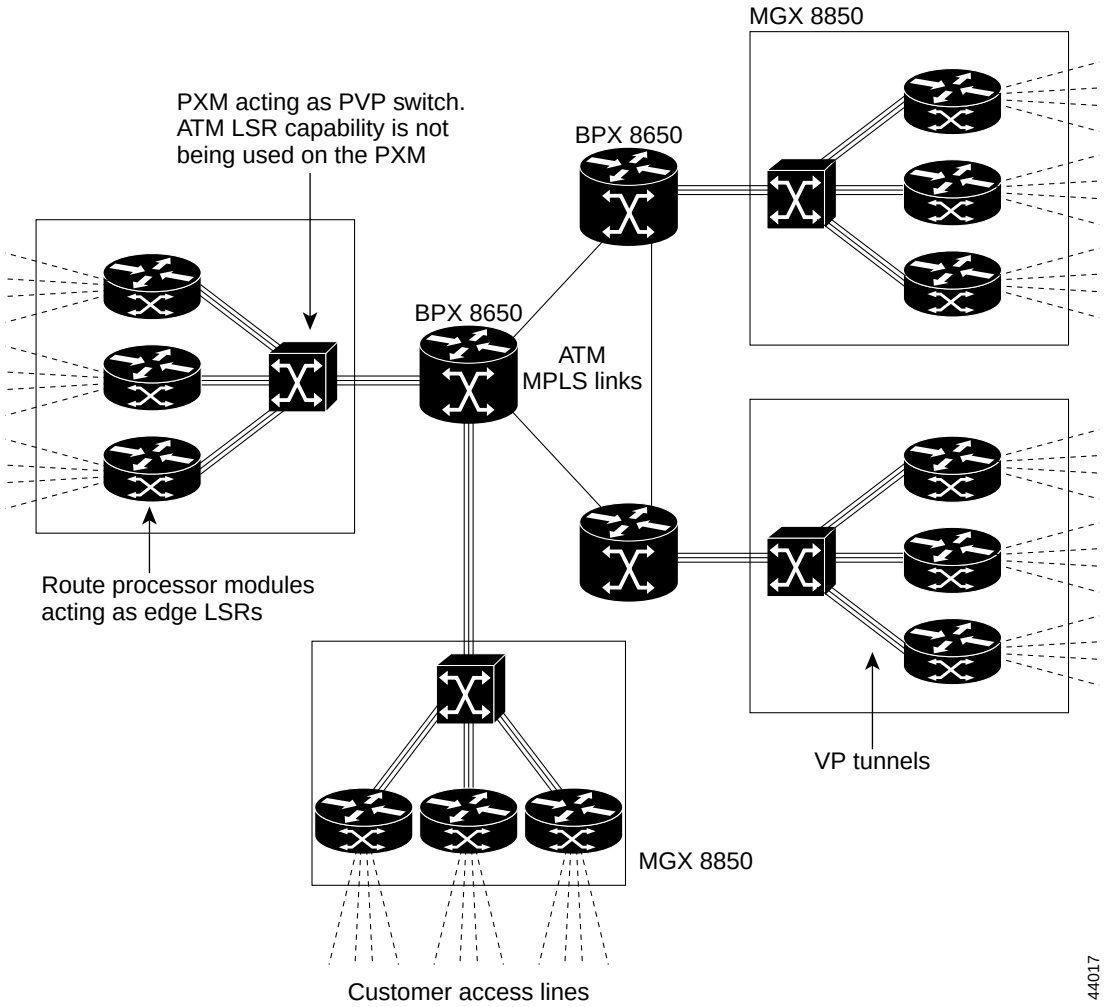
In the current release, the MGX 8850 does not support Label Switch Controller (LSC) function. When the MGX 8850 does support LSC function, the switch with an LSC will be able to set up LVCs directly on ATM trunks. Until then, LVCs must be set up within Permanent Virtual Paths (PVPs). These PVPs act as a type of “virtual trunk,” and are otherwise known as MPLS VP Tunnels.

ATM MPLS, by way of VP Tunnels, can work with RPMs in two different ways:

- It is possible to use RPMs as Edge LSRs linked by PVPs, without using ATM MPLS on the core switches, as illustrated in Figure 7-1. However, there is little advantage to the use of PVPs in meshed MPLS configurations, and the use of PVCs is simpler.

- A more usual use of ATM MPLS is when the core ATM switches support ATM MPLS, such as in BPX 8650 switches. This is illustrated in Figure 7-3.

Figure 7-3 MPLS for the MGX 8850 with an ATM MPLS Network Core, Using no LSC on the MGX 8850



In any of these network configurations, the RPM also supports an MPLS feature, MPLS Virtual Private Networks (VPNs). In MPLS VPN operation, the RPM will act as a Provider Edge (PE) router. PE router function is a combination of MPLS Edge LSR function and the use of the Border Gateway Protocol (BGP) v4 with Multiprotocol Extensions to carry routing information for the VPNs.

MPLS in an MGX 8850 Switch

On the MGX 8850 platform, MPLS provides an IP solution without the cost of Layer 2 management. In contrast to IP over ATM, MPLS reduces the customer's network management. Also, MPLS provides the same level of privacy as does Frame Relay or ATM.

For a description of how the RPM acts as an Edge LSR to support MPLS feeder functionality, refer to the section, ""System Block Diagram" section on page 7-5.

Features

The RPM supports the following features for MPLS:

- Edge LSR functionality in the RPM.
- Ability to run MPLS traffic over a PVC between RPM Edge LSRs or between an RPM and routers such as the Cisco 7500.
- Ability to run MPLS traffic over a PVP between RPM Edge LSRs or from an RPM Edge LSR to a BPX 8650 switch with a Label Switch Controller (LSC).
- Ability to run packet-based MPLS traffic over the RPM Ethernet and Fast Ethernet port adaptor ports.
- MPLS PVC or PVP connections limits that fall within the established connection limits for the software release.

  These connection limits stem from the MGX 8850 platform, not the MPLS feature. However, if the platform imposes the limit, the MPLS feature does not support any capacity beyond them.
- MPLS VPN.
- Protocol support provided by IGP-OSPF, RIP, EIGRP, IS-IS.
- VPN addition provided by BGP, RIPv2, static routes for PE-CE links.
- Ability to support ~2000 interface descriptor blocks (IDBs) for the RPM-PR and ~700 IDBs for the RPM/B.

  Note If an interface does not contain any sub-interfaces, then it constitutes one sub-interface for the purpose of this limit.

- RPM switch interface can support 3,840 VCs (PVCs and/or LVCs) and 255 PVPs.

  Note Due to the limit of 2000 sub-interfaces, the total of PVCs is limited to less than 3840 in some configurations, and it is not always possible to use all 255 PVPs.

- Packet-based MPLS over PVCs.
- ATM MPLS over PVPs.

  The RPM also can support ATM MPLS without the use of PVPs. This feature will be supported once the MGX 8850 has LSC support.

Limitations

There may be no automatic switchovers in an MGX 8850 switch or node

System Block Diagram

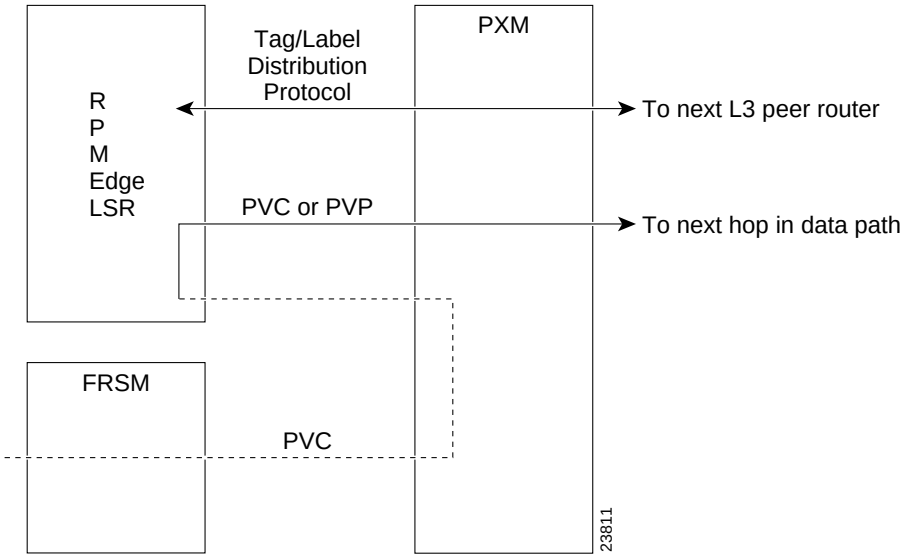
The RPM acts as an Edge LSR, with user data entering an FRSM card, flowing on a PVC to an RPM, to a PVP connection or PVC (see Figure 7-4), and on to the next hop in the data path. In this example, the FRSM associates the data with a PVC. The other end of the PVC terminates at the RPM switch port.

The RPM receives the packets and optionally provides Layer 3 services. Then, based on the Layer 3 destination address, the RPM forwards the packet to a PVP or PVC.

In the case where a PVP is used, the Edge LSR uses the VCI field in the ATM cell header for the MPLS label. The VPI value is specified statically when the PVP is provisioned.

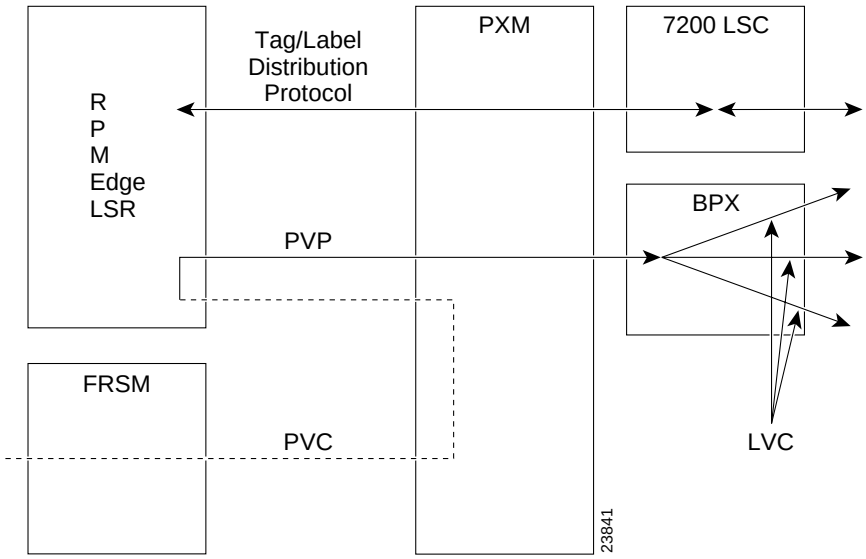
In the case where a PVC is used, the Edge LSR labels the packet and then segments it into ATM cells. The VPI/VCI values are specified statically when the PVC is provisioned. Therefore, the label exists only in the payload of the ATM cell.

Figure 7-4 Edge LSR Function, Mesh Configuration



In Figure 7-5, an MPLS-enabled core is shown. The LSC creates cross-connects in an ATM switch so that labeled packets can be forwarded through the switch. The BPX 8650 switch and the RPM Edge LSR use LDP/ TDP to identify labels. Because the connection between the BPX 8650 switch and the Edge LSR is a PVP, the VPI is static. This is an MPLS VP tunnel and therefore the VCI field is used as the label. The LSC establishes cross-connects in the BPX 8650 switch so VC connections in the PVP are broken out and individually switched. Such label forwarding is not possible when a PVC is used, because the label does not exist in the ATM cell header.

Figure 7-5 MGX 8850 Edge LSR with MPLS-Enabled BPX Core



VPN Overview

Virtual Private Networks (VPNs) provide the appearance, functions, and usefulness of a dedicated private network. The VPN feature for MPLS allows a Cisco IOS network to deploy scalable IPv4 Layer 3 VPN backbone service with private addressing, controlled access, and service-level guarantees between sites.

VPNs are supported by service provider networks over which labeled packets are forwarded from RPM Edge LSRs to other RPM Edge LSRs. A VPN service creates multiple private network environments within the public infrastructure. Service providers can use VPNs to target a given clientele and deliver individualized private network services to that clientele in a secure IP environment by using the public infrastructure.

Requirements

The requirements for an effective VPN are

- **Privacy**—All IP VPN services offer privacy over a shared (public) network infrastructure, the most well known solution of which is an encrypted tunnel. An IP VPN service must offer private addressing, where addresses within a customer private network do not need to be globally unique.
- **Scalability**—IP VPN services must scale to serve hundreds of thousands of sites and users. An IP VPN service should also serve as a management tool for service providers to control access to services, such as closed user groups for data and voice services. Controlled access places performance limits upon authorized programs, processes, or other systems in a network.
- **Flexibility**—IP VPN services must accommodate any-to-any traffic patterns and be able to accept new sites quickly, connect users over different media, and meet transport and bandwidth requirements of new intranet applications.

- **Predictable Performance**—Intranet applications supported by an IP an IP VPN service require different classes of service. The service level performance between customer sites must be guaranteed. Examples include widespread connectivity required by remote access for mobile users and sustained performance required by interactive intranet applications in branch offices.

MPLS VPN Features

Beyond the functions of an IP VPN, the VPN features for MPLS allow a Cisco IOS network to deploy the following scalable IPv4 Layer 3 VPN backbone services:

- **Connectionless Service**—MPLS VPNs are connectionless. They are less complex because they do not require tunnels or encryption to ensure network privacy.
- **Centralized Service**—VPNs in Layer 3 privately connect users to intranet services and allow flexible delivery of customized services to the user group represented by a VPN. VPNs deliver IP services such as multicast, QoS, and telephony support within a VPN, and centralized services like content and web hosting. Combinations of services can be customized for individual customers.
- **Scalability**—MPLS based VPNs use Layer 3 connectionless architecture and are highly scalable.
- **Security**—MPLS VPNs provide the same security level as connection-based VPNs. Packets from one VPN cannot accidentally go to another VPN. At the edge of a provider network, incoming packets go to the correct VPN. On the backbone, VPN traffic remains separate.

  Note Spoofing of a PER is nearly impossible because incoming packets are IP packets and must be received on an interface or subinterface uniquely identified with a VPN tag.

- **Easy to Create**—MPLS VPNs are connectionless. It is easy to add sites to intranets and extranets and to form closed user groups. A given site can have multiple memberships.
- **Flexible Addressing**—MPLS VPNs provide a public and private view of addresses, enabling customers to use their own unregistered or private addresses. Customers can freely communicate across a public IP network without network address translation (NAT).
- **Straightforward Migration**—MPLS VPNs can be built over multiple network architectures, including IP, ATM, Frame Relay, and hybrid networks. There is no requirement to support MPLS on the customer edge (CE) router.

Supported Platforms

All Cisco routers from the 3600 series up support VPNs, as do the MGX 8850 node with RPM, the 6400 series, and several other devices. Any LSR-capable platform can serve in the backbone. In addition to devices already mentioned, the LS 1010 ATM Switch, 8540 MSR, and the BPX 8650 switch are supported. Non-MPLS capable switches can also be used, as they can carry MPLS over PVCs or PVPs.

How VPNs Work

Each VPN is associated with one or more VPN routing/forwarding instances (VRFs), which defines a VPN at a customer site attached to a PE router. A VRF table contains the following information.

- IP routing table
- Derived Cisco Express Forwarding table
- Set of interfaces that use the forwarding table
- Set of rules and routing protocol variables that determine what goes into the forwarding table

VPNs for MPLS

A customer site can be a member of multiple VPNs. However, a site can be associated with only one VRF. A customer site's VRF contains all routes available to the site from the associated VPNs.

The IP routing table and CEF table for each VRF store packet forwarding information. (Together, these tables are analogous to the forwarding information base [FIB] used in MPLS.) A logically separate set of routing and CEF tables is constructed for each VRF. These tables prevent packets from being forwarded outside a VPN and prevent packets outside a VPN from being forwarded to a router within the VPN.

VPN Route-Target Communities and Export and Import Lists

The distribution of VPN routing information is controlled through the use of VPN route-target communities, implemented by Border Gateway Protocol (BGP) extended communities. Distribution works as follows:

- When a VPN route is injected into BGP, it is associated with a list of VPN route-target communities. This list is set through an export list associated with the VRF from which the route was learned.
- Associated with each VRF is an import list of route-target communities, which defines values to be verified by the VRF table before a route is deemed eligible for import into the VPN routing instance. For example, if a given VRF's import list includes community-distinguishers A, B, and C, then any VPN route carrying A, B, or C is imported into the VRF.

iBGP Distribution of VPN Routing Information

A LER learns an IP prefix from a CE router through static configuration, a BGP session, RIP, or OSPF. The LER then generates a VPN-IPv4 (vpnv4) prefix by linking an 8-byte route distinguisher to the IP prefix. The VPN-IPv4 address uniquely identifies hosts within each VPN site, even if the site uses globally non-unique (unregistered private) IP addresses. The route distinguisher used to create the VPN-IPv4 prefix is specified by a configuration command on the LER.

BGP uses VPN-IPv4 addresses to distribute network reachability information for each VPN within a service provider network. In building and maintaining routing tables, BGP sends routing messages *within* (interior BGP or iBGP) or *between* IP domains (exterior BGP or eBGP).

BGP propagates vpnv4 information using BGP multiprotocol extensions for handling extended addresses. Refer to RFC 2283, *Multiprotocol Extensions for BGP-4*. BGP propagates reachability information (expressed as VPN-IPv4 addresses) among PE routers; reachability information for a given VPN is propagated only to members of that VPN. BGP multiprotocol extensions identify valid recipients of VPN routing information.

Label Forwarding

Based on the routing information stored in each VRF's IP routing and CEF tables, MPLS uses extended VPN-IPv4 addresses to forward packets to their destinations.

To achieve this, an MPLS label is associated with each customer route. The PE router assigns the route originator's label and directs data packets to the correct CE router. Tag forwarding across the provider backbone is based on dynamic IP paths or Traffic Engineered paths.

A customer data packet has two levels of labels attached when it is forwarded across the backbone.

- The top label directs the packet to the correct PE router.
- The second label indicates how that PE router should forward the packet.

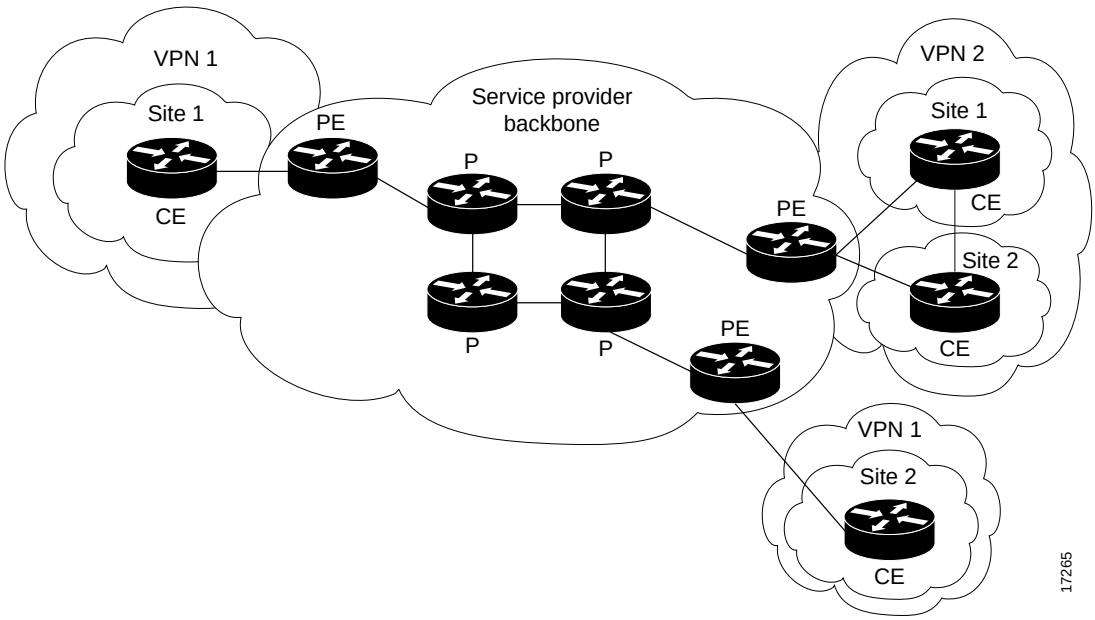
The PE router associates each CE router with a forwarding table that contains only the set of routes that are available to that CE router.

Example VPN Topologies

A VPN contains customer devices attached to CE routers. These customer devices use the VPN to exchange data. Only the PE routers are aware of the VPN.

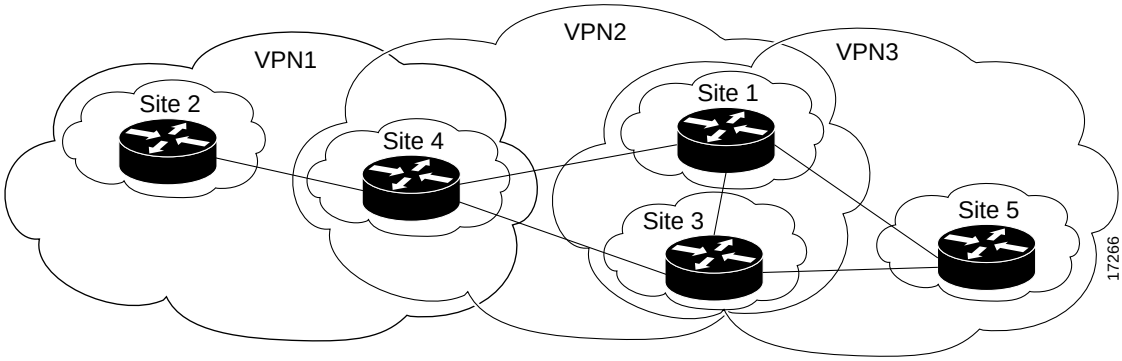
An example of a VPN with a service provider (P) backbone network, service PE routers, and CE routers is shown in Figure 7-6.

Figure 7-6 VPN with a Service Provider (P) Backbone Network



Three VPNs communicating with five customer sites are shown in Figure 7-7. Notice that sites 1, 3, and 4 are members of two VPNs.

Figure 7-7 VPNs Communicate with Customer Sites



Configuring a VPN

This section explains how to configure the RPM for VPN operation, including listing the prerequisites for VPN configuration and the configuration procedures.

Prerequisites for VPN Operation

The network must be running the following Cisco IOS services before you can configure VPN operation:

- CEF switching in every tag-enabled router
- MPLS connectivity among all provider edge (PE) routers with VPN service or MPLS in all provider backbone (P) routers
- MPLS with VPN code in all provider routers with a VPN PE routers
- BGP in all routers providing a VPN service

Complete the following tasks before you configure VPN operation:

- Turn on Cisco Express Forwarding (CEF).
- Configure MPLS.
- Turn on BGP between provider routers for distribution of VPN routing information.

Configuring VPN Operation

The following sections describe how to configure routing protocols and create VPFs for a VPN. The commands used in the tasks are described in more detail in the “VPN Overview” section. Perform the following four tasks to configure and verify VPNs in your network:

1. Configure VRFs and associate interfaces with VRFs.
2. Configure BGP between provider routers for distribution of VPN routing information.

3. Configure import and export routes to control the distribution of routing information.
4. Verify VPN operation.

Configuring VRFs

To create a VRF, perform the following steps on the provider edge router:

Step 1 Enter VRF configuration mode and specify the VRF to which subsequent commands apply.

```
RPM(config)# ip vrf vrf-name
```

Step 2 Define the instance by assigning a name and an 8-byte route distinguisher.

```
RPM(config-vrf)# rd route-distinguisher
```

Step 3 Associate interfaces with the VRF.

```
RPM(config-if)# ip vrf forwarding vrf-name
```

Step 4 If BGP is used between the PE and a VRF CE, configure BGP parameters for the VRF CE session.

```
RPM(config# address-family ipv4 vrf name
RPM(config-af)# aggregate-address
RPM(config-af)# auto-summary
RPM(config-af)# default-information originate
RPM(config-af)# default-metric ...
RPM(config-af)# distance ...
RPM(config-af)# distribute-list ...
RPM(config-af)# network ...
RPM(config-af)# neighbor ...
RPM(config-af)# redistribute ...
RPM(config-af)# synchronization
RPM(config-af)# table-map...
```

Note To ensure that addresses learned from CE routers via BGP are properly treated as VPN IPv4 addresses on a PE router, enter the command **no bgp default ipv4-activate** before configuring any CE neighbors. See Step 2 and Step 3 in the next section, “Configuring BGP” below.

Step 5 If RIP is used between the PE and VRF CEs, configure RIP parameters (in a VRF address-family submode).

Note The default for auto-summary and synchronization in VRF address-family submode is off.

```
RPM(config)# address-family ipv4 vrf name
RPM(config-af)# auto-summary
RPM(config-af)# default-information originate
RPM(config-af)# default-metric ...
RPM(config-af)# distance ...
RPM(config-af)# network ...
RPM(config-af)# offset-list ...
RPM(config-af)# redistribute ...
```

Step 6 Exit from the address family config mode.

```
config-af# exit-address-family
```

Step 7 Configure static routes for the VRF.

```
RPM(config)# ip route [vrf vrf-name] destination <interface> ip_address
```

Configuring BGP

To configure router address families, define sessions, and set global variables for routing protocols, perform the following steps with the PE router in configuration mode.

Step 1 Configure BGP address families.

```
RPM(config)# address-family {ipv4 | vpnv4}[unicast | multicast]
```

Step 2 Define BGP sessions.

```
RPM(config-af)# neighbor address | peer-group} remote-as as-number
RPM(config-af)# neighbor address | peer-group} update-source interface
RPM(config-af)# neighbor peer-group peer-group
RPM(config-af)# neighbor address peer-group peer-group
```

Step 3 Activate a BGP session by entering the **no bgp default ipv4-activate** to prevent automatic advertisement of **address family IPv4** for every neighbor. This command is required on a PE that establishes BGP sessions with CE routers. To enable advertisement of IPv4 prefixes for a particular neighbor, enter address-family mode for IPv4 then use the **neighbor...activate** command for the neighbor.

```
RPM(config)# no bgp default ipv4-activate
```

For a particular address family, use **neighbor... activate**.

```
RPM(config-af)# [no] neighbor address |peer-group} activate
```

Step 4 Enter optional BGP global commands that affect all address families.

```
RPM(config)# bgp always-compare-med
RPM(config)# bgp bestpath ...
RPM(config)# bgp client-to-client reflection
RPM(config)# bgp cluster-id ...
RPM(config)# bgp confederation ...
RPM(config)# bgp default local-preference ...
RPM(config)# bgp deterministic-med ...
RPM(config)# bgp fast-external-fallover ...
RPM(config)# bgp log-neighbor-changes
RPM(config)# bgp redistribute-internal
RPM(config)# bgp router-id ...
RPM(config)# timers bgp ...
```

Step 5 Enter the BGP configuration commands for address family IPv4.

All BGP configuration commands supported in previous versions of IOS are valid for address family IPv4 unicast. These commands affect either all IPv4 instances or the default IPv4 routing table. For backward compatibility, these commands can be entered in either router config mode or in address family mode for ipv4 unicast. See Step 3 for information on the command **no bgp default ipv4-activate**.

```
RPM(config)# bgp ...
```

Step 6 Enter the BGP configuration commands for address family VPNv4.

```
RPM(config-af)# bgp dampening ...
RPM(config-af)# neighbor ...
RPM(config-af)# neighbor address | peer-group}activate
```

Step 7 To configure iBGP to exchange VPNv4 Network Layer Reachability Information (NLRI) (between PE router and route reflector or between PE routers), first define an iBGP BGP session.

Note To ensure that VPN packets are properly tag forwarded between the PE routers, specify loopback addresses for the neighbor address and the update-source interface.

```
RPM(config)# neighbor address remote-as as-number
RPM(config)# neighbor address update-source interface
```

Step 8 Activate the advertisement of VPNv4 NLRIs.

```
RPM(config)# address-family vpnv4
RPM(config-af)# neighbor address activate
```

Configure Import and Export Routes

To configure VRF route target extended communities and import route maps, perform the following steps with the PE router in configuration mode.

Step 1 Enter VRF configuration mode and specify a VRF.

```
RPM(config)# ip vrf vrf-name
```

Step 2 Import routing information from the specified extended community.

```
RPM(config-vrf)# route-target import community-distinguisher
```

Step 3 Export routing information to the specified extended community.

```
RPM(config-vrf)# route-target export community-distinguisher
```

Step 4 Associate the specified route map with the VRF being configured.

```
RPM(config-vrf)# import map route-map
```

Checking the VRFs

Perform the following steps to verify VPN configuration:

Step 1 Display the set of defined VRFs and the interfaces associated with each one.

```
RPM# show ip vrf
```

Step 2 Display detailed information about configured VRFs, including the import and export community lists.

```
RPM# show ip vrf detail
```

Step 3 Display the IP routing table for VRF.

```
RPM# show ip route vrf vrf-name
```

Step 4 Display the routing protocol information associated with a VRF.

```
RPM# show ip protocols vrf vrf-name
```

Step 5 Display the CEF forwarding table associated with a VRF.

```
RPM# show ip cef vrf vrf-name
```

Step 6 Display the VRF table associated with an interface. Use either of the following commands:

```
RPM# show ip interface interface-number
RPM# show cef interface interface-number
```

Step 7 Display VPNv4 NLRI information. The keyword **all** displays the entire database. The keyword **rd** displays NLRIs that match the specified route distinguisher. The keyword **vrf** displays NLRIs with the specified VRF. Add the keyword **tags** after any of the other keywords and arguments to list the tags distributed with the VPNv4 NLRIs.

```
RPM# show ip bgp vpnv4 all [tags]
RPM# show ip bgp vpnv4 rd route-distinguisher [tags]
RPM# show ip bgp vpnv4 vrf vrf-name [tags]
```

Step 8 Display tag forwarding entries that correspond to VRF routes advertised by this router.

```
RPM# show tag-switching forwarding vrf vrf-name [prefix mask/length] [detail]
```

Step 9 You can also use **ping** or **traceroute**.

```
RPM# ping vrf vpn 1.1.1.1
```

where 1.1.1.1 is the destination address.

Step 10 Enter the following **telnet** command to check the VRFs.

```
telnet 1.1.1.1 /vrf vpn
```

Configuring an ATM PVC for Carrying Packet-Based MPLS

This section describes how to add PVC connections for packet-based MPLS connectivity in a network core, using the command line interface of IOS. With packet-based MPLS over PVCs, a PVC is created to every other RPM in the network. In this simple example, there are just two RPMs, both in the same MGX 8850, so there is one PVC. The PVC connects the RPMs through through the Cellbus. Therefore, for each connection from an RPM to another MPLS device over a PVC, you must create:

- A subinterface connected to the PVC, with MPLS enabled.
- An ATM PVC between the RPM and the cellbus.

From either a control terminal connected to the RPM or through the MGX 8850 switch, go to the IOS command line interface, then perform the following steps (unless they have already been done):

Step 1 Enable Cisco Express Forwarding (CEF).

Step 2 Specify a routing protocol.

Step 3 Specify the area in which the RPM can communicate.

Step 4 Configure the subinterface.

Step 5 Create an ATM PVC so the RPM can communicate with the cellbus.

Step 6 Ping the far end router to verify connectivity.

Step 7 Add VPN configuration (this is described later).

The following items must be the same on the RPMs at both ends.

- Routing protocol (preferably OSPF or IS-IS)
- Routing area (specified by a network area number)

All configuration tasks require you to enable configuration mode, as follows.

```
TErpm4>
TErpm4>ena
Password:
```

To establish user-connections for MPLS edge routing, perform the following steps:

Step 1 Enter the password.

The prompt changes to include a pound sign (#). At this level, you can show aspects of the RPM per the IOS commands and list the configuration commands. but you cannot actually execute configuration commands.

```
TErpm4#
```

Step 2 Enter configuration mode and include a specification for the configuration source. The source is terminal, memory, or network. The syntax and resulting display are,

```
TErpm4#config term
Enter configuration commands, one per line. End with CNTL/Z.
TErpm4(config)#
```

Step 3 If this is not done, activate support for CEF, as follows.

```
TErpm4(config)#ip cef
```

Step 4 If necessary, configure resource partitioning for the RPM. You can enter the **rpmrscprtn** command at any point before adding the user-connection, however, its executive level makes resource partitioning more convenient before you enter the subinterface level.

rpmrscprtn *<partition_type> <percent_ingressBW> <percent_egressBW> <min_vpi> <max_vpi> <min_vci> <max_vci> <max_lcns>*

- *partition_type* identifies the network controller. Choices are PAR, MPLS, and PNNI.
- *percent_ingressBW* is the percent of available bandwidth for the ingress direction (towards the cellbus).
- *percent_egressBW* is the percent of available bandwidth for the egress direction (away from the cellbus)
- *min_vpi* is the minimum vpi within the range 0–255. (Note that once you set the minimum vpi, it is the lower limit of the range for maximum vpi.)
- *max_vpi* is the maximum vpi within the range 0–255.
- *min_vci* is the minimum vci. The vci range is 0–3840.
- *max_vci* is the maximum vci. The vci range is 0–3840.

- *max_lcns* is the maximum number of LCNs for this controller. The range is 0–4080.

For example,

```
TErpm4(config)#rpmrscprtn par 100 100 10 10 10 3000 2000
```

Note The MGX 8850 CLI has the partitioning ability to support MPLS (or "tag") control of the MGX resources. The "tag" partition will be required once the MGX 8850 has support for an RPM acting as a Label Switch Controller (LSC). LSC support is not yet available, so the "tag" partition is not used. In the current example, MPLS connectivity is provided by way of PVCs. PVCs use resources from the Portable AutoRoute (PAR) partition if PNNI is not used, or from the PNNI partition if PNNI is used. (Technically, an SPVC and not a PVC is used with PNNI).

Step 5 Enter the **router** command to specify the routing protocol for the RPM,.

```
TErpm4(config)#router <protocol> <PID>
```

- *protocol* is any routing protocol such as OSPF, EIGRP, RIP, and IS-IS.
- *PID* is a process identification number.

The recommended protocols are OSPF or IS-IS. The PID can be any integer in the range 1–65535.

Note A router can communicate with only those routers that have the same protocol unless you execute the optional **redistribute** command to specify protocol translation (see the IOS command reference for details).

Step 6 Enter the **network** command to specify a n*etwork area*.

MPLSA network area is a number that an *entity* must have in common with another entity for communication to occur. The entity is defined by an IP address or a subnet mask (or both). The syntax is:

```
RPM_name(config)#network <IP address> <mask> <area> <area_number>
```

- ***area*** indicates the area number follows
- *area_number* is a number you associate with the IP address and mask. The range for *area_number* is 1–65535.

For example:

```
TErpm4(config-subif)#network 212.212.212.0 0.0.0.255 area 200
```

For each of the preceding lines, each entity can communicate with any other suitable entity if the network area number is the same. For example, the first example line assigns the network area number 200 to the current node, so this node can communicate with other nodes that have a network area number of 200.

Step 7 Enter the **interface** command to specify a subinterface on the RPM.

If the subinterface does not exist, the first-time specification of a subinterface *creates* the interface. Thereafter, when you provide the number of the subinterface to **interface**, you *enter* that interface. The syntax is:

```
RPM_name(config)#interface switch subinterface_number link
```

- **switch** indicates an interface between the RPM and the cellbus.

- *subinterface_number* indicates the shelf number (always "1" because the node has one cellbus), (and a subinterface number in the range 1–700 for RPM/B and 1–2000 for RPM-PR. Note the slash and the period in this parameter. Specify **point-to-point** subinterface.

For example:

```
TErpm4(config)#interface switch 1.200 point-to-point
```

- **switch** is an extension indicating the RPM's ATM interface.
- cellbus *interface number* is always "**1**" because currently only one cellbus slave exists on the RPM.
- *subinterface* is 200. The range for subinterfaces is 1–700 for RPM/B and 1–2000 for RPM-PR. You must also configure the subinterface to be point-to-point, multipoint, or MPLS. With point-to-point or MPLS, each subinterface has one PVC. With multipoint, a subinterface has one IP address but multiple connections to one or more RPMs.

Step 8 Assign an IP address to the subinterface.

Normally, in an ATM MPLS network, subinterfaces in the network are not numbered, but are unnumbered. It is less important to do this in a packet-based MPLS network (that is, one using PVCs), but it still may be done, and it does lead to the simplest configuration. If an unnumbered interface is used, the interface address is taken to be the address of a loopback interface on the router. This procedure minimizes the number of addresses and routes in the network, and minimizes the number of MPLS labels used.

To do this, enter the following command,

```
RPM(config-subif)#ip unnumbered loopback0
```

Alternatively, an IP address could be assigned by using an **ip address** command.

Step 9 Configure the PVC. Each subinterface must have a connection to the cellbus. The command is **atm PVC**:

```
atm pvc vcd vpi aal-encap [[midlow midhigh] [peak average burst] [oam seconds] [inarp
minutes]
```

For example,

```
rpm(config-subif)#atm PVC 10 0 10 aal5snap 100000 50000 10000 inarp 10 oam ?
  <0-600>  OAM loopback frequency(seconds)
```

- *vcd* is a user-specified connection identifier with significance on the local RPM only. It refers to the connection whether the connection is a VCC or VPC. You can specify any integer, but using the same value as the vci (or vpi when applicable) helps to avoid possible confusion.
- *vpi* or ATM network virtual path identifier of this PVC is always **0** (for a VCC).
- *vci* or ATM network virtual channel identifier is **10**.
- *aal-encap* encapsulation is aal5snap.
- *peak cell rate* is 100000.
- *average cell rate* is 50000.
- *maximum burst size* is 10000.
- *inarp* is enabled by its inclusion on the line. This parameter enables periodic reporting on the presence of each far-end interface by way of an IP address. If you enable inarp, the parameter that follows it is the time between reports. The number of minutes between inarp reports is 10 in the current example.
- *oam cell circulation* is enabled. The current example shows the device that requests information about the next parameter. For this parameter, the range for the intervals between OAM cell transmission is 0–600 seconds.

Step 10 Enable MPLS on this subinterface.

Execute the following command.

```
RPM(config-subif)#tag-switching ip
```

This command enables MPLS using the Tag Distribution Protocol for label distribution.

Step 11 Specify an IP address for each subinterface on the RPM.

```
TErpm4(config-subif)#ip addr 162.32.188.17 255.255.255.0
TErpm4(config-subif)#exit
TErpm4(config)#
```

Step 12 Add a connection between the local and remote RPMs through **addcon**. The syntax is:

```
addcon <connection_type> <switch> <switch.subinterface> <local_vci> <rslot> <switch>
<remote_vpi> <remote_vci> [master local]
```

- *connection_type* is either **vcc** or **vpc**. For this connection, type **vcc**.
- **switch** indicates this device is an RPM and that the virtual switch identification follows.
- *switch.subinterface* identifies the virtual switch interface. The *slot* identifies the RPM slot. The *switch* is always 1. The *subinterface* is a number in the range 1–700 for RPM/B and 1–2000 for RPM-PR.
- **rslot** indicates that the remote slot number follows.
- remote *switch* number is always **1**.
- *remote vpi* of **0** for a VCC where the remote end is another RPM.
- *remote_vci* is the remote VCI. It may take any value, and is not necessarily the same as the *local_vci*.
- **master local** identifies the local end of the connection as the master. If the other end is the master, do not enter either **master** or **local** for this parameter.

For example,

```
TErpm4(config-subif)#addcon vcc switch 1/1.200 1012 rslot 10 1 0 1012 master local
```

Step 13 Add the connection at the other endpoint. Where appropriate, use identical parameters and unique parameters (such as **master** connection).

Step 14 Verify that the connection exists by using the **dspcons, dspchans, tstcon, tstconseg, dspslotcon,** or **dspportcon** commands on the PXM and **show atm pvc, show atm vc, show switch conn**, and the **ping** commands on the RPM.

Step 15 Add more connections as needed.

Note Remember that, for each packet-based MPLS connection over a PVC created with **addcon**, you must first specify a subinterface and add an ATM PVC between the RPM and the cellbus.

The IOS-version of the **addcon** command adds a local user-connection between the RPM and another RPM in the MGX 8850 switch. For a three-segment connection in an ATM or Frame Relay network, you must also add a segment between the edges of the cloud. Through the CLI of the BPX 8600 series switch, you enter the switch-software version of **addcon**.

Three-Segment Connections

A three-segment connection consists of a local connection between an RPM and PXM at each of two MGX 8850 switches and a connection between two endpoints in an ATM or Frame Relay cloud.

Configuring a Virtual Path Tunnel

This section describes how to add PVP connections for ATM MPLS connectivity in a network core, using the command line interface of IOS. With ATM MPLS using PVPs, a PVP is created from the RPM to the nearest ATM-LSR, for example, a BPX 8650. The ATM-LSR then connects to the rest of the ATM MPLS network.

The RPM terminates the PVP on a subinterface configured for ATM MPLS. The ATM-LSR must terminate the PVP on a virtual trunk interface. On the BPX 8650, virtual trunk interfaces must be on UNI or NNI ports, and must not be on feeder trunks. This setup creates additional requirements on the MGX 8850. An MGX 8850 would normally be connected to the adjacent node by a link configured as a trunk or feeder trunk, but one additional link is required to use MPLS ATM MPLS over PVPs, for a total of two links.

Note If it is essential to use a single link, for example, if an MGX 8850 system with a PXM-1 card is connected to a BPX 8650 with a single OC12/STM-4 feeder trunk, then it is still possible to use the BPX 8650 as an ATM-LSR as a work-around. Contact TAC if you need to do this.

Therefore, for each MPLS connection from an RPM to an ATM-LSR over a PVP, you must create:

- A UNI or NNI link to the ATM-LSR, if it not already present. (This is typically either a PXM-1 link, or an AXSM link in the case of PXM-45 system).
- An ATM PVP between the link and the RPM.
- A subinterface connected to the PVP, with MPLS enabled.

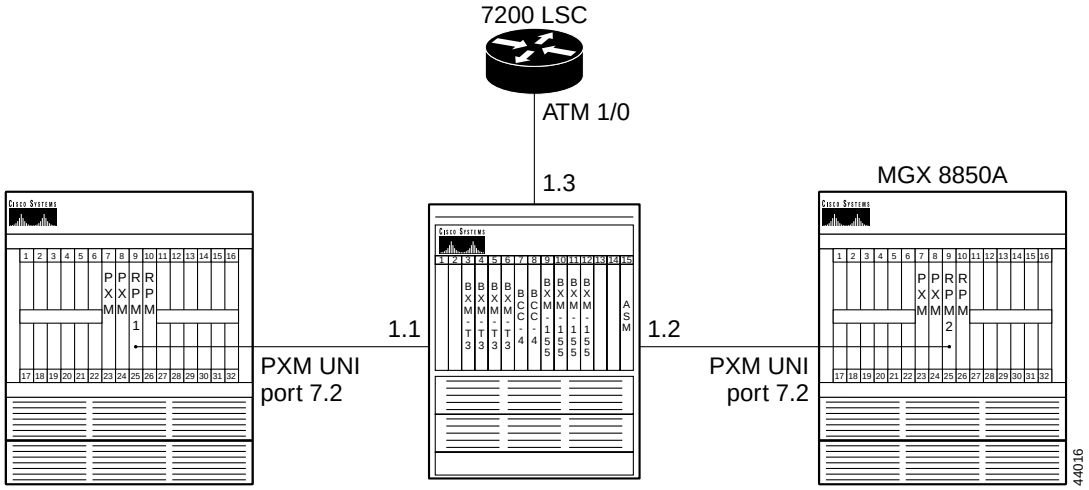
From either a control terminal connected to the RPM or through the MGX 8850 switch, go to the IOS command line interface, then perform the following tasks (skip any completed task):

1. Enable Cisco Express Forwarding (CEF).
2. Specify a routing protocol.
3. Specify the area in which the RPM can communicate.
4. Configure the subinterface.
5. Create an ATM PVP.
6. Ping the far end router to verify connectivity.
7. Add VPN configuration (this is described later).

The following items must be the same on the RPMs at both ends:

- Routing protocol (preferably OSPF or IS-IS).
- Routing area (specified by a network area number).

Figure 7-8 Configuring a Virtual Path Tunnel



This example shows there are two MGX 8850 nodes and a BPX 8650. Each MGX 8850 has a PXM-1 card supporting 4xSTM-1 links. The UNI link between each MGX 8850 and BPX 8650 is link number 2 on the PXM-1 card, which is in slot 7. Each link connects to a 4-port BXM card in the BPX 8650 switch, and the links are 1.1 and 1.2, for example, card 1, ports 1 and 2. The BPX 8650 also has a 7200 Label Switch Controller connected to port 1.3. The MGX 8850 may also have a feeder trunk to the BPX 8650, which would be in slot 1 of the PXM-1 card. (The feeder trunk is not used by MPLS in this example, and is not shown.)

The following example describes the RPM configuration in detail, and also summarizes the required PXM-1, BPX 865,0 and LSC configuration.

PXM-1 Configuration Summary

If the UNI link to the BPX has not already been created, create it now. A typical configuration is as follows. (For more information on configuring PXM-1, refer to the *Cisco MGX 8850 Multiservice Switch Installation and Configuration* guide, Chapter 6, “Card and Service Configuration.”) The configurations of both PXM-1 cards in the example are identical.

Step 1 Enter the **addln** command to enable the link.

```
addln 7.2
```

Step 2 Enter the **addport** command to configure a logical port on the link.

```
addport 2 2 100 0 4095
```

The logical port number is “2”,which can be different from the physical line number, 2, if required. This command gives full control of the port to Portable AutoRoute, so that a PVP may be set up on it. The **addport** command also has an “MPLS” option, but that is not used with PVPs. It will be used once the MGX 8850 has LSC support.

Step 3 Enter the **cnfatmln** command to declare the port as a UNI.

```
cnfatmln 2 2
```

The first “2” is the physical line number, the second “2” indicates “UNI.”

RPM1 Configuration

To create a VP tunnel, enter the following steps.

Step 1 Enter configuration mode, as follows.

```
TErpm4>
TErpm4>ena
Password:
```

Enter the password.

The prompt subsequently includes a pound sign (#). At this command level, you can show aspects of the RPM per the IOS commands and list configuration commands, while not actually entering them.

```
TErpm4#
```

Step 2 Enter configuration mode and include a specification for the configuration source. The source is terminal, memory, or network. The syntax and resulting display are:

```
TErpm4#config term
Enter configuration commands, one per line. End with CNTL/Z.
TErpm4(config)#
```

Step 3 If you have not already indicated the switch-level support for Cisco Express Forwarding, do so now by entering the **ip cef** command.

```
TErpm4(config)#ip cef
```

Step 4 Create the VP-tunnel by entering the **tag-switching** command. Note that the subinterfaces you subsequently create for this tunnel must be of the MPLS switching type (rather than point-to-point or multipoint). The syntax is

```
RPM_name(config-subif)#tag-switching atm vp-tunnel <VP-tunnel_number> [vci-range]
```

- *VP-tunnel_number* is the vpi for the tunnel. The tunnel vpi must be the same at both ends of the tunnel.
- *vci-range* is from 33 to 1000.

For example,

```
TErpm4(config-subif)#tag-switch ATM VP-tunnel 50
```

Step 5 If you have not already specified the router protocol for the RPM, do so now by entering the **router** command.

```
RPM_name (config)#router <protocol> <PID>
```

- *protocol* is any router protocol such as OSPF, EIGRP, RIP, or ISIS.
- *PID* is a process identification number. Typically, OSPF is the protocol. The PID can be any integer you want.

Step 6 Enter the **network** command to specify a network area, which is a number that a communications *entity* must have in common with another entity for communication to occur. The entity is defined by an IP address or a subnet mask (or both).

```
RPM_name(config)#network <IP address> <mask> <area> <area_number>
```

- **area** indicates that an area number follows.
- *area_number* is a number you associate with the IP address and mask. The range for *area_number* is 1–65535.

For example,

```
TErpm4(config)#network 10.1.0.0 0.0.255.255 area 0
```

In the preceding example, the command assigns the network area number 200 to the current node, so this node can communicate with other nodes that have a network area number of 200.

Step 7 Enter the **interface** command to specify a subinterface on the RPM. If the subinterface does not already exist, the first-time specification of a subinterface *creates* the interface. Thereafter, when you provide the number of the subinterface to **interface**, you enter that interface. The syntax is

```
RPM_name(config)#interface switch shelf.subinterface_number link
```

- switch indicates an interface between the RPM and the cellbus.
- *shelf.subinterface_number* indicates the RPM shelf number (always "**1**" because the RPM connects to only one cellbus)
- *subinterface number* is in the range 1–700 for the RPM/B and 1–2000 for the RPM-PR. Note the slash and the period in this parameter.
- *link* is **point-to-point**, **MPLS**, or **multipoint**. You must specify point-to-point.

For example,

```
TErpm4(config)# interface switch/1.200 MPLS
```

- **switch** is an extension indicating an RPM.
- cellbus *interface number* is always 1 because only one cellbus exists on the switch
- *subinterface* is 200. which is in the range of 1–700 for the RPM/B and 1–2000 for the RPM-PR. Note the slash and the period in this parameter.
- *link* is **MPLS**. To create a VP-tunnel, the controller for the subinterface must be MPLS.
  Note also that, with MPLS or point-to-point, each subinterface has one PVC. With multipoint, a subinterface has one IP address but multiple connections that can terminate on one or more RPMs.

Step 8 Enter the **atm PVC** command to configure each subinterface connection to the cellbus.

```
atm PVC vcd vpi aal-encap [[midlow midhigh] [peak average burst] [oam seconds] [inarp
minutes]
```

For example,

```
rpm(config-subif)#atm PVC 50 50 0 aal5snap vbr-nrt 10000 10000 64000
  <0-600>  OAM loopback frequency(seconds)
  <cr>
```

- *vcd* is **10**. The VCD is a user-specified connection identifier with significance only on the local RPM. It refers to the connection whether the connection is a VCC or VPC. You can specify any integer, but using the same value as the VPI (or VPI when applicable) helps to avoid possible confusion.
- *vci* of **0**, with a *vpi* of **50,** configures a PVP. Another value may be chosen if desired.
- *vbr-nrt 10000 10000 64000* configures the VP for **CBR** shaping with a peak rate of **10** Mb/s.
- *aal-encap* encapsulation is **aal5snap**.

- *peak cell rate* is **100000**.
- a*verage cell rate* is **5000**.
- *maximum burst size* is **10000**.
- **inarp** enables inarp, which enables periodic reporting on the presence of far-end interfaces by way of IP addresses. If you enable inarp, the next parameter is the time between reports.
- *minutes* between **inarp** reports is **10**.
- **oam** cell circulation is enabled. This example shows the prompt that requests information about the next parameter. For this parameter, the range for the intervals between OAM cell transmission is 0–600 seconds.

Step 9 Enter the **ip addr** command to specify an IP address for each subinterface on the RPM.

```
TErpm4(config-subif)#ip addr 162.32.188.17 255.255.255.0
```

Step 10 Exit the current level of configuration.

```
TErpm4(config-subif)#exit
```

Step 11 If necessary, **cc** to the card to configure a resource partition and enter the **rpmrscprtn** command.

Resource partitions are not a subinterface-level entity. Therefore, exit the subinterface if necessary (as in Step 10.

rpmrscprtn *<partition_type> <percent_ingressBW> <percent_egressBW> <min_vpi> <max_vpi> <min_vci> <max_vci> <max_lcns>*

For example

```
TErpm4(config)#rpmrscprtn par 100 100 10 10 10 3000 2000
```

- *partition_type* identifies the network controller. Choices are PAR, MPLS, and PNNI.
- *percent_ingressBW* is the percent of available bandwidth for the ingress direction (towards the cellbus).
- *percent_egressBW* is the percent of available bandwidth for the egress direction (away from the cellbus)
- *min_vpi* is the minimum VPI within the range 0–255. (Note that once you set the minimum vpi, it is the lower limit of the range for maximum VPI.)
- *max_vpi* is the maximum VPI, within the range 0–255.
- *min_vci* is the minimum VCI. The VCI range is 0–3840.
- *max_vci* is the maximum VCI. The VCI range is 0–3840.
- *max_lcns* is the maximum number of LCNs for this controller. The range is 0–4080.

Step 12 Enter the **addcon** command to add a VP tunnel between the local and remote RPMs.

addcon *<connection_type>* **switch** *<slot/switch.subinterface> <local_vpi>* **rslot** *<slot> <switch> <remote_vpi>* [master local]

- *connection_type* is either **vcc** or **vpc**. For this connection, type **vpc**.
- **switch** indicates this device is an RPM and that the virtual switch identification follows.
- *slot/switch.subinterface* identifies the virtual switch interface. The *switch* is always **1**.
- **rslot** indicates that the remote slot number follows.
- *slot* is the slot number of the remote RPM.
- Remote *switch* number is always **1**.

- *remote_vpi* is the remote VPI and must be the same as the *local_vpi*.

Note The keywords **master local** let you identify the local end of the connection as the master. If the other end is the master, enter nothing (do not enter either **master** or **local**).

Step 13 Add the connection at the other endpoint. Where appropriate, use identical parameters such as the VPI or unique parameters such as the connection mastership specification.

Step 14 Verify that the connection exists by entering the **dspcons** command.

Step 15 Continue to add more VP-tunnels as needed.

The IOS version of the **addcon** command adds a local user-connection between the RPM and another endpoint in the MGX 8850 switch. For a three-segment connection in an ATM or Frame Relay network, you must also add a middle segment between the edges of the cloud. Through the CLI of the BPX 8600 series switch, you would enter the switch-software version of **addcon**.

The following example shows a typical configuration

```
---
hostname RPM1
!
ip cef
!
interface loopback0
ip address 10.1.1.1 255.255.255.255
!
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
!
---
```

RPM2 Configuration

The configuration of the second RPM should be the same as that of the first RPM, except that the loopback address should be 10.1.1.3 not 10.1.1.1, as shown in the following example.

```
---
hostname RPM2
!
ip cef
!
interface loopback0
ip address 10.1.1.3 255.255.255.255
!
!
```

```
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
---
```

BCC Configuration

The following paragraphs show a summary of the commands required on the BCC CLI and the BPX 8650 node. For more details of the BPX8650 and LSC configuration, refer to the *Cisco MPLS Controller Software Configuration Guide*.

The PVPs terminate on VSI Virtual Trunk interfaces on ports 1.1 and 1.2. In this example, only one virtual trunk is needed on each interface, and it is numbered 1. If required, there could be more than one virtual trunk per interface, with any numbers in the range 1 to 31.

```
uptrk 1.1.1
uptrk 1.2.1
```

The LSC is connected to a trunk, and not a virtual trunk, as shown in the following example.

```
uptrk 1.3
```

The VSI virtual trunk interfaces must now have virtual trunk parameters configured with the **cnftrk** command. Most of the **cnftrk** parameters are relevant only for virtual trunks carrying PVCs, not MPLS LVCs, and can therefore be left at their default values. There are the following exceptions.

- Trunk bandwidth must be set correctly.
  - 26,000 cells per second or about 10 Mb per second in this example
- The appropriate VPI must be chosen
  - 50 in this example

```
cnftrk 1.1.1 26000 N 1000 7F V,...,RT-VBR N TERRESTRIAL 10 0 0 N N N CBR 50 0
cnftrk 1.2.1 26000 N 1000 7F V,...,RT-VBR N TERRESTRIAL 10 0 0 N N N CBR 50 0
```

Enter the **cnfrsrc** command to assign resources for MPLS use on the subinterfaces and interfaces. On all interfaces, MPLS is guaranteed to be able to use 1000 LVCs, and permitted to use up to 4000 if resources are spare. The PVP endpoints use a VPI of 50, but the link to the LSC has the range of VPIs 2-10 assigned to MPLS. The PVPs are configured for a bandwidth of 26000 cells per second (about 10mb/s), but 260,000 cells per second are guaranteed for MPLS on the link to the LSC.

```
cnfrsrc 1.1.1 256 0 1 e 1000 4000 50 50 26000 26000
cnfrsrc 1.2.1 256 0 1 e 1000 4000 50 50 26000 26000
cnfrsrc 1.3 256 0 1 e 1000 4000 2 10 260000 260000
```

Enter the **addshelf** command to add the LSC.

```
addshelf 1.3 vsi 1 1
```

LSC Configuration

A typical LSC configuration is shown in the following example. For more details on configuring an LSC, refer to the *Cisco MPLS Controller Software Configuration Guide*.

In the LSC, it is not necessary to specify that the interfaces 1.1.1 and 1.1.2 are "VP tunnels." The LSC automatically detects this from information passed to the LSC by the BPX. The LSC also automatically detects the valid VPI, 50, because this was configured with the **cnfrsrc** commands on the BPX.

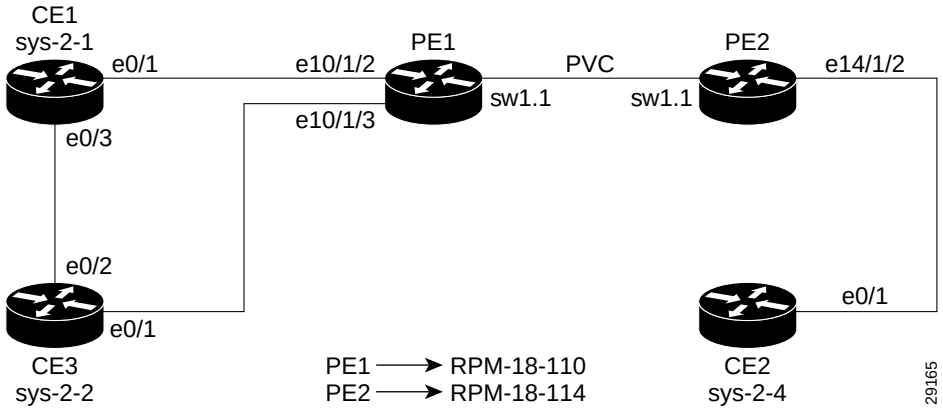
```
ip cef switch
!
interface lo0
ip address 10.1.1.2 255.255.255.255
!
interface atm1/0
no ip address
tag-control-protocol vsi
!
interface XTagATM111
extended-port atm1/0 bpx 1.1.1
ip unnumbered loopback0
tag-switching ip
!
interface XTagATM121
extended-port atm1/0 bpx 1.2.1
ip unnumbered loopback0
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
```

RPM Configuration Examples for MPLS-based Virtual Private Networks

The examples in this section use the same configuration, with two PEs and a single VPN containing 3 CEs. (Many more VPNs could be added if needed.) For simplicity, both RPMs are in the same MGX 8850 shelf, and are linked by a PVC. Any other linking of RPMs can also be used.

In the following example, CE1 and CE2 have a fairly sophisticated configuration, with a "back door" link between each other, which is a connection that is not part of the VPN. CE3 has a simpler configuration that easier to implement and therefore, more commonly used.

Figure 7-9 VPN Configuration



The CEs are connected to the MGX 8850 by Frame Relay PVCs. In this example, the three CEs are connected to a single FRSM card in slot 18 of the MGX 8850. Each CE is connected to a separate T1 port in a FRSM-8T1 card.

FRSM Configuration

The following example shows a typical FRSM configuration. For more details, see the "Frame over ATM Example" section on page 6-18 of this manual. For a full description of Service Module configuration options, refer to the *Cisco MGX 8850 Multiservice Switch Installation and Configuration, Release 1.1.31*, Chapter 6, "Card and Service Configuration."

Step 1 Enter the **addln** command to configure the first line.

```
Example.1.18.FRSM.a> addln 1
```

Step 2 Enter the **addport** command to configure a Frame Relay logical port on the line.

```
Example.1.18.FRSM.a> addport 1 1 2 1 24 1
```

This command configures a Frame Relay data link using the whole T1 rate, for example, all 24x64kb/s time slots on the link.

- **1**—define this to be logical port 1 (could use another number in range 1-192)
- **1**—physical line is 1
- **2**—DSO speed is chosen to be 64k per T1 time slot
- **1**—beginning time slot is chosen to be 1
- **24**—last time slot is 24
- **1**—this is a Frame Relay port (not FUNI or frame forwarding)

Step 3 Enter the **xcnfport** command to configure LMI on the line.

```
Example.1.18.FRSM.a> xcnfport -pt 11 -sig 3
```

- **pt 1**—logical port is 1, as defined above
- **sig 3**—specifies StrataLMI

Step 4 Enter the **addcon** command to configure a service-interworking or network-interworking channel from the FRSM port to PE1.

```
Example.1.18.FRSM.a> addcon 1 123 1536000 3 2 1 2 Example.9.1.0.101
```

- **1**—port number as defined above
- **123**—choose DLCI 123 on the Frame Relay data link
- **1536000**—committed information rate is 1536000bits/s, for example, full T1 rate
- **3**—channel type is service interworking
- **2**—connection use VBR-rt queueing into the cellbus
- **1**—connection uses Portable AutoRoute PVC routing, not PNNI
- **2**—this end of the connection is the slave end, (which means that the RPM is the master)

```
Example.9.1.0.101
```

The other end of the PVC connection is in the same node (called “Example”), slot 9 (which is an RPM, PE1), port 1 (must be 1 for an RPM, it is the Cellbus interface), VPI 0 (must be 0 for a PVC on the RPM), and the VCI is chosen to be 101.

The second customer link also has one PVC, DLCI 123. This is cross-connected to a different VCI on PE1, namely 102.

```
addln 2
addport 2 2 2 1 24 1
xcnfport -pt 2 -sig 3
addcon 2 123 1536000 3 2 1 2 Example.9.1.0.102
```

The third customer link again has one PVC, DLCI 123. This customer link connects to PE2 in slot 11, using VCI 101.

```
addln 3
addport 3 3 2 1 24 1
xcnfport -pt 3 -sig 3
addcon 3 123 1536000 3 2 1 2 Example.11.1.0.101
```

Two PE–Three CE Configuration BGP-connected CE routers

The following example shows the most sophisticated and flexible way of setting up routing between the CE and PE routers, which is to use BGP between them. (This is distinct from the normal use of BGP in a VPN backbone.)

CE1 Configuration

This is an example of the CE1 configuration.

```
hostname CE1
!
interface Ethernet0
ip address 172.16.1.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
```

```
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123
ip address 10.101.1.2 255.255.255.252
no ip directed-broadcast
!
router ospf 100
redistribute bgp 101
network 172.16.0.0 0.0.255.255 area 100
!
router bgp 101
redistribute ospf 100
no synchronization
network 172.16.0.0
neighbor 10.101.1.1 remote-as 100
!
```

CE2 Configuration

This is an example of the CE2 configuration.

```
hostname CE2
!
interface Ethernet0
ip address 172.16.1.2 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.2.2 255.255.255.252
no ip directed-broadcast
!
router ospf 100
redistribute bgp 101
network 172.16.0.0 0.0.255.255 area 100
!
router bgp 101
redistribute ospf 100
no synchronization
network 172.16.0.0
neighbor 10.101.2.1 remote-as 100
!
```

CE3 Configuration

This is an example of the CE3 configuration.

```
hostname CE3
!
interface Ethernet0
ip address 172.16.3.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
```

```
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.3.2 255.255.255.252
no ip directed-broadcast
!
router ospf 100
redistribute bgp 101
network 172.16.0.0 0.0.255.255 area 100
!
router bgp 101
no synchronization
redistribute ospf 100
network 172.16.0.0
neighbor 10.101.3.1 remote-as 100
!
```

PE1 Configuration

This is an example of the PE1 configuration.

```
hostname RPM1
!
ip vrf vpn1! Define a VRF for VPN 1
rd 100:1
route-target export 100:1
route-target import 100:1
!
ip cef
!
interface loopback0
ip address 10.1.1.1 255.255.255.255
!
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
interface Switch1.101
ip address 10.101.1.1 255.255.255.252
pvc 0/101
encap aal5snap
vbr-nrt 1500 1500 64000
ip vrf forwarding vpn1
!
interface Switch1.102
ip address 10.101.2.1 255.255.255.252
pvc 0/102
encap aal5snap
vbr-nrt 1500 1500 64000
ip vrf forwarding vpn1
!
router bgp 100
  no synchronization
```

```
  no bgp default ipv4-unicast
  neighbor 212.212.212.2 remote-as 100 !define BGP connection to PE2 for IPv4
  neighbor 212.212.212.2 update-source Loopback0
  !
  address-family vpnv4!define BGP connection to PE2 for VPN routes
  neighbor 212.212.212.2 activate
  neighbor 212.212.212.2 send-community extended
  exit-address-family
  !
  address-family ipv4 vrf vpn1! Define BGP PE-CE sessions for vpn1
  neighbor 10.101.1.2 remote-as 101
  neighbor 10.101.1.2 activate
  neighbor 10.101.2.2 remote-as 101
  neighbor 10.101.2.2 activate
  no auto-summary
  no synchronization
  exit-address-family
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
addcon vcc Switch1.101 101 rslot 18 1 0 123 master local
addcon vcc Switch1.102 102 rslot 18 2 0 123 master local
!
```

PE2 Configuration

This is an example of the PE2 configuration.

```
hostname RPM1
!
ip vrf vpn1! Define a VRF for VPN 1
rd 100:1
route-target export 100:1
route-target import 100:1
!
ip cef
!
interface loopback0
ip address 10.1.1.1 255.255.255.255
!
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0

interface Switch1.101
ip address 10.101.3.1 255.255.255.252
pvc 0/101
encap aal5snap
vbr-nrt 1500 1500 64000
ip vrf forwarding vpn1
!
router bgp 100
  no synchronization
  no bgp default ipv4-unicast
  neighbor 212.212.212.1 remote-as 100!define BGP connection to PE1 for IPv4
```

```
  neighbor 212.212.212.1 update-source Loopback0
  !
  address-family vpnv4!define BGP connection to PE1 for VPN routes
  neighbor 212.212.212.1 activate
  neighbor 212.212.212.1 send-community extended
  exit-address-family
  !
  address-family ipv4 vrf vpn1! Define BGP PE-CE3 session for vpn1
  neighbor 10.101.3.2 remote-as 101
  neighbor 10.101.3.2 activate
  no auto-summary
  no synchronization
  exit-address-family
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
addcon vcc Switch1.101 101 rslot 18 1 0 123 master local
!
```

Two PE–Three CE Configuration, RIP-connected CE Routers

This is similar to the previous examples except that RIP is used between CE and PE routers. The use of RIP is not recommended when there are “back-door” routes between customer sites, for example, links between CEs, except through the VPN network.

CE1 Configuration

This is an example of the CE1 configuration.

```
hostname CE1
!
interface Ethernet0
ip address 172.16.1.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.1.2 255.255.255.252
no ip directed-broadcast
!
router rip
version 2
network 10.0.0.0
network 172.16.0.0
no auto-summary
!
```

CE2 Configuration

This is an example of the CE2 configuration.

```
hostname CE2
!
```

```
interface Ethernet0
ip address 172.16.2.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.2.2 255.255.255.252
no ip directed-broadcast
!
router rip
version 2
network 10.0.0.0
network 172.16.0.0
no auto-summary
!
```

CE3 Configuration

This is an example of the CE3 configuration.

```
hostname CE3
!
interface Ethernet0
ip address 172.16.3.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.3.2 255.255.255.252
no ip directed-broadcast
!
router rip
version 2
network 10.0.0.0
network 172.16.0.0
no auto-summary
!
```

PE1 Configuration

This is an example of the PE1 configuration.

```
hostname RPM1
!
ip vrf vpn1! Define a VRF for VPN 1
rd 100:1
route-target export 100:1
route-target import 100:1
!
ip cef
```

```
!
interface loopback0
ip address 10.1.1.1 255.255.255.255
!
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
interface Switch1.101
ip address 10.101.1.1 255.255.255.252
pvc 0/101
encap aal5snap
vbr-nrt 1500 1500 64000
ip vrf forwarding vpn1
!
interface Switch1.102
ip address 10.101.2.1 255.255.255.252
pvc 0/102
encap aal5snap
vbr-nrt 1500 1500 64000
ip vrf forwarding vpn1
!
router bgp 100
no synchronization
no bgp default ipv4-unicast!define BGP connection to PE2 for IPv4
neighbor 212.212.212.2 remote-as 100
neighbor 212.212.212.2 update-source Loopback0
!
address-family vpnv4!define BGP connection to PE2 for VPN routes
neighbor 212.212.212.2 activate
neighbor 212.212.212.2 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1!logical connection to vrf1
redistribute static
no auto-summary
exit-address-family
!
ip route vrf vpn1 172.16.1.0 255.255.255.0 Switch1.101
ip route vrf vpn1 172.16.2.0 255.255.255.0 Switch1.102
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
addcon vcc Switch1.102 102 rslot 18 2 0 123 master local
addcon vcc Switch1.101 101 rslot 18 1 0 123 master local
!
```

PE2 Configuration

This is an example of the PE2 configuration.

```
hostname RPM1
!
ip vrf vpn1! Define a VRF for VPN 1
rd 100:1
route-target export 100:1
```

```
route-target import 100:1
!
ip cef
!
interface loopback0
ip address 10.1.1.1 255.255.255.255
!
interface Switch1
no ip address
!
interface Switch1.1 tag-switching
ip unnumbered Loopback0
atm pvc 50 50 0 aal5snap vbr-nrt 10000 10000 64000
tag-switching atm vp-tunnel 50
tag-switching ip
!
router ospf 1
network 10.1.0.0 0.0.255.255 area 0
interface Switch1.101
ip address 10.101.3.1 255.255.255.252
pvc 0/101
encap aal5snap
vbr-nrt 1500 1500 64000
!
router bgp 100
no synchronization
no bgp default ipv4-unicast
neighbor 212.212.212.1 remote-as 100!define BGP connection to PE1 for IPv4
neighbor 212.212.212.1 update-source Loopback0
!
address-family vpnv4!define BGP connection to PE1 for VPN routes
neighbor 212.212.212.1 activate
neighbor 212.212.212.1 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1!logical connection to vrf1
redistribute static
no auto-summary
exit-address-family
!
ip route vrf vpn1 172.16.3.0 255.255.255.0 Switch1.101
!
rpmrscprtn par 100 100 1 100 10 4000 3800
addconn vpc switch 1/1.1 50 rslot 0 1 50 master local
addcon vcc Switch1.101 101 rslot 18 1 0 123 master local
!
```

Two PE–Three CE Configuration, Static routing to CE Routers

This is similar to the RIP example except that Static routing is used between CE and PE routers. This results in the simplest but least flexible configuration.

CE1 Configuration

This is an example of the CE1 configuration.

```
hostname CE1
!
interface Ethernet0
ip address 172.16.1.1 255.255.255.0
```

```
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.1.2 255.255.255.252
no ip directed-broadcast
!
ip route 172.16.1.0 255.255.255.0 Ethernet0
ip route 0.0.0.0 0.0.0.0 Serial0!default route:serial link
!
```

CE2 Configuration

This is an example of the CE2 configuration.

```
hostname CE2
!
interface Ethernet0
ip address 172.16.2.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.1.2 255.255.255.252
no ip directed-broadcast
!
ip route 172.16.2.0 255.255.255.0 Ethernet0
ip route 0.0.0.0 0.0.0.0 Serial0!default route:serial link
!
```

CE3 Configuration

This is an example of the CE3 configuration.

```
hostname CE3
!
interface Ethernet0
ip address 172.16.3.1 255.255.255.0
no ip directed-broadcast
!
interface Serial0
no ip address
encapsulation frame-relay
service module t1 clock source line
!
interface Serial0.1 point-to-point
frame-relay interface-dlci 123

ip address 10.101.1.2 255.255.255.252
no ip directed-broadcast
```

```
!
ip route 172.16.3.0 255.255.255.0 Ethernet0
ip route 0.0.0.0 0.0.0.0 Serial0!default route:serial link
!
```

PE1 Configuration

This is an example of the PE1 configuration.

```
rpm-18-110#sho run
Building configuration...

Current configuration:
!
version 12.0
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname rpm-18-110
!
boot system tftp mpls/12.0/rpm-js-mz.120-5.T.bin 3.3.0.1
no logging console
!
!
!
!
!
clock timezone EST -5
clock summer-time EDT recurring
ip subnet-zero
no ip domain-lookup
ip host ios-lab-fw 3.3.0.1
!
!
ip vrf vpn1
 rd 100:1
 route-target export 100:1
 route-target import 100:1
ip cef
cns event-service server
!
process-max-time 200
!
interface Loopback0
 ip address 11.11.11.11 255.255.255.255
 no ip directed-broadcast
!
interface Loopback1
 no ip address
 no ip directed-broadcast
!
interface Ethernet1/1
 ip address 3.3.18.110 255.255.0.0
 no ip directed-broadcast
 no ip mroute-cache
 no keepalive
!
interface Ethernet1/2
 ip vrf forwarding vpn1
 ip address 50.0.0.2 255.0.0.0
```

```
 no ip directed-broadcast
 no ip mroute-cache
 no keepalive
 tag-switching ip
!
interface Ethernet1/3
 bandwidth 100
 ip vrf forwarding vpn1
 ip address 51.0.0.1 255.0.0.0
 no ip directed-broadcast
 no ip mroute-cache
 shutdown
 tag-switching ip
 no fair-queue
!
interface Ethernet1/4
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 no keepalive
!
interface FastEthernet2/1
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
!
interface Switch1
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
!
interface Switch1.1 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 50 50 0 aal5snap
 tag-switching atm vp-tunnel 50
 tag-switching ip
!
interface Switch1.2 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 30 30 0 aal5snap
 tag-switching atm vp-tunnel 30
 tag-switching ip
!
interface Switch1.3 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 60 60 0 aal5snap
 tag-switching atm vp-tunnel 60
 tag-switching ip
!
router ospf 100
 passive-interface Ethernet1/2
 passive-interface Ethernet1/3
 network 11.0.0.0 0.255.255.255 area 100
 network 50.0.0.0 0.255.255.255 area 100
 network 51.0.0.0 0.255.255.255 area 100
!
router bgp 100
 no synchronization
 no bgp default ipv4-unicast
 neighbor 10.10.10.10 remote-as 100
 neighbor 10.10.10.10 update-source Loopback0
```

```
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 redistribute static
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 10.10.10.10 activate
 neighbor 10.10.10.10 send-community extended
 exit-address-family
!
ip default-gateway 3.3.0.1
no ip classless
ip route vrf vpn1 12.0.0.0 255.0.0.0 Ethernet1/2 50.0.0.1
ip route vrf vpn1 13.0.0.0 255.0.0.0 Ethernet1/3 51.0.0.2
ip route vrf vpn1 50.0.0.0 255.0.0.0 Ethernet1/2 50.0.0.1
ip route vrf vpn1 51.0.0.0 255.0.0.0 Ethernet1/3 51.0.0.2
ip route vrf vpn1 52.0.0.0 255.0.0.0 Ethernet1/2 50.0.0.1
ip route vrf vpn1 52.0.0.0 255.0.0.0 Ethernet1/3 51.0.0.2
no ip http server
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 password lab
 login
!
exception core-file mpls/mgx/dumps/rpm-18-110.core
rpmrscprtn PAR 100 100 0 255 0 3840 4080
addcon vpc switch 1.2 30 rslot 0 3 30 master local
addcon vpc switch 1.1 50 rslot 14 1 50
addcon vpc switch 1.3 60 rslot 0 4 60 master local
end

rpm-18-110#
rpm-18-110#
```

PE2 Configuration

This is an example of the PE2 configuration.

```
rpm-18-114#sho run
Building configuration...

Current configuration:
!
version 12.0
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname rpm-18-114
!
boot system tftp mpls/12.0/rpm-js-mz.120-5.T.bin 3.3.0.1
no logging console
!
```

```
!
!
clock timezone EST -5
clock summer-time EDT recurring
ip subnet-zero
no ip domain-lookup
ip host ios-lab-fw 3.3.0.1
!
!
ip vrf vpn1
 rd 100:1
 route-target export 100:1
 route-target import 100:1
ip cef
cns event-service server
!
!
process-max-time 200
!
interface Loopback0
 ip address 10.10.10.10 255.255.255.255
 no ip directed-broadcast
!
interface Loopback1
 no ip address
 no ip directed-broadcast
!
interface Ethernet1/1
 ip address 3.3.18.114 255.255.0.0
 no ip directed-broadcast
 no ip mroute-cache
 no keepalive
!
interface Ethernet1/2
 bandwidth 100
 ip vrf forwarding vpn1
 ip address 53.0.0.1 255.0.0.0
 no ip directed-broadcast
 no ip mroute-cache
 tag-switching ip
 no fair-queue
!
interface Ethernet1/3
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
!
interface Ethernet1/4
 bandwidth 100
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
!
interface Switch1
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
!
interface Switch1.1 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 50 50 0 aal5snap
 tag-switching atm vp-tunnel 50
```

```
 tag-switching ip
!
interface Switch1.2 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 40 40 0 aal5snap
 tag-switching atm vp-tunnel 40
 tag-switching ip
!
interface Switch1.3 tag-switching
 ip unnumbered Loopback0
 no ip directed-broadcast
 atm pvc 20 20 0 aal5snap
 tag-switching atm vp-tunnel 20
 tag-switching ip
!
router ospf 100
 passive-interface Ethernet1/2
 network 10.0.0.0 0.255.255.255 area 100
 network 53.0.0.0 0.255.255.255 area 100
!
router bgp 100
 no synchronization
 no bgp default ipv4-unicast
 neighbor 11.11.11.11 remote-as 100
 neighbor 11.11.11.11 update-source Loopback0
 !
 address-family ipv4 vrf vpn1
 redistribute connected
 redistribute static
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 11.11.11.11 activate
 neighbor 11.11.11.11 send-community extended
 exit-address-family
!
ip default-gateway 3.3.0.1
no ip classless
ip route vrf vpn1 14.0.0.0 255.0.0.0 Ethernet1/2 53.0.0.2
ip route vrf vpn1 53.0.0.0 255.0.0.0 Ethernet1/2 53.0.0.2
no ip http server
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 password lab
 login
!
exception core-file mpls/mgx/dumps/rpm-18-114.core
rpmrscprtn PAR 100 100 0 255 0 3840 4080
addcon vpc switch 1.3 20 rslot 0 2 20 master local
addcon vpc switch 1.2 40 rslot 0 1 40
addcon vpc switch 1.1 50 rslot 10 1 50 master local
end

rpm-18-114#
```

Support for LDP

MPLS label distribution protocol (LDP) allows the construction of highly scalable and flexible IP Virtual Private Networks (VPNs) that support multiple levels of services. 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's MPLS-based IP VPNs and IP+ATM services across multivendor MPLS networks.

LDP is a superset of Cisco's prestandard 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, such as the encoding of protocol messages, for example.

This release of IOS, which supports both the LDP and TDP protocols, provides the means for transitioning an existing network from a TDP operating environment to an LDP operating environment. Thus, you can run LDP and TDP simultaneously on any given router platform. The routing protocol that you select can be configured on a per-interface basis for directly- connected neighbors and on a per-session basis for nondirectly connected (targeted) neighbors. In addition, a label switch path (LSP) across an MPLS network can be supported by LDP on some hops and by TDP on other hops.

For more information, including configuration tasks, transitioning a network from TDP to LDP, and command reference, see “MPLS Label Distribution Protocol” in the Cisco IOS Release 12.2T documentation at
http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t2/ldp_221t.htm

Note There is no CWM support planned for LDP or TDP.

Support for Multi-VC on the RPM-PR

This feature enables support for initiation of Multiple label switched paths (LSPs) per destination on the RPM. Different label switched paths are established for different class of services. This feature enables interface level queueing rather than per-vc level on the RPM based on MPLS class of service policy.

MPLS quality of service (QoS) functionality enables network administrators to satisfy a wide range of requirements in transmitting IP packets through an MPLS-enabled network.The three primary MPLS QoS offerings made available to customers are:

- Packet classification
- Congestion avoidance
- Congestion management

For more information, see “MPLS QoS Multi-VC Mode for PA-A3” in the Cisco IOS Release 12.2T documentation at
http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t2//cos1221t.htm

Note There is no CWM support for Multi-LVC.

Maintaining the MGX RPM

This appendix describes maintenance procedures you might need to perform as your internetworking needs change. It contains the following sections:

- Reading Front Panel LEDs
- Recovering a Lost Password
- Following is an overview of the steps in the password recovery procedure:
- Virtual Configuration Register Settings
- Copying a Cisco IOS Image to Flash Memory

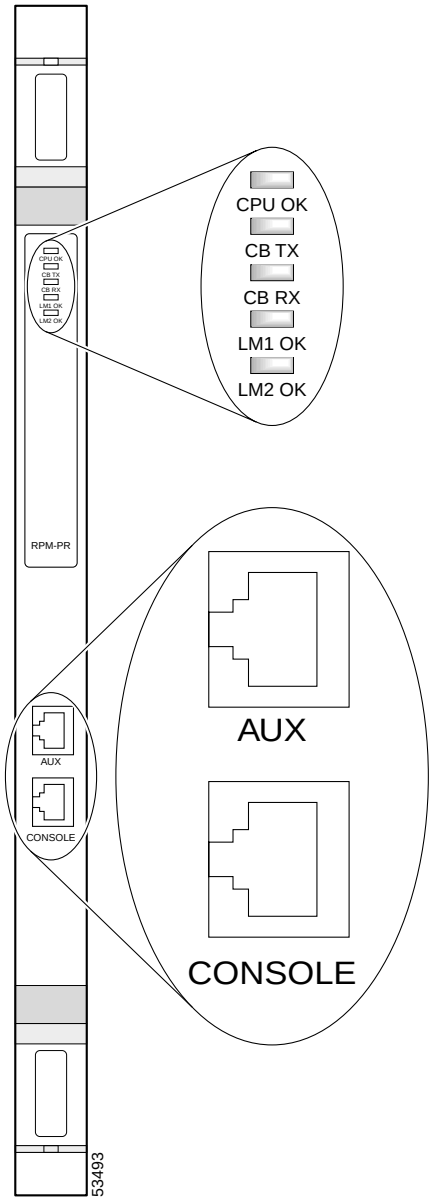
Caution Before performing any procedures described in this appendix, ensure that you have discharged all static electricity from your body and be sure the power is OFF. Also, review Chapter 2, "Preparing to Install the MGX RPM" in the sections "Safety Recommendations" and "General Site Requirements."

Reading Front Panel LEDs

The LEDs on the front panel of the RPM indicate the current operating condition of the RPM. You can observe the LEDs, note the fault condition the RPM is encountering. Contact your system administrator or TAC, if necessary.

Figure A-1 shows the front panel and LEDs of the RPM. Table A-1 shows how to interpret front-panel LED activity.

Figure A-1 MGX 8850 RPM Front Panel LEDs



The LEDs are labeled and indicate overall status and activity on ports by flickering. When there is heavy activity on a port, the LED might be on constantly. If an LED is not on when the port is active and the cable is connected correctly, there might be a problem with the port.

Table A-1 Front Panel LEDs

LED NAME	COLOR	DEFINITION
CPU STATUS	OFF	CPU is not operational
	GREEN	CPU is running
BC1 STATUS	OFF	Port Adapter one is not present
	GREEN	Port Adapter one is present and enabled

Table A-1 Front Panel LEDs (continued)

LED NAME	COLOR	DEFINITION
BC2 STATUS	OFF	Port Adapter two is not present
	GREEN	Port Adapter two is present and enabled
CB RX CELLS	GREEN	Cells are being received from the cellbus
CB TX CELLS	GREEN	Cells are being transmitted to the cellbus

Recovering a Lost Password

This section describes how to recover a lost enable or console login password, and how to replace a lost enable secret password on your RPM.

Note It is possible to recover the enable or console login password. The enable secret password is encrypted, however, and must be replaced with a new enable secret password.

Following is an overview of the steps in the password recovery procedure:

- If you can log in to the RPM, enter the **show version** command to determine the existing configuration register value.
- Press the **Break** key to get to the bootstrap program prompt (ROM monitor). You might need to reload the system image by power cycling the RPM.
- Change the configuration register so the following functions are enabled: Break; ignore startup configuration; boot from Flash memory.

  Note The key to recovering a lost password is to set the configuration register bit 6 (0x0040) so that the startup configuration (usually in NVRAM) is ignored. This will allow you to log in without using a password and to display the startup configuration passwords.

- Power cycle the RPM by turning power off and then back on.
- Log in to the RPM and enter the privileged EXEC mode.
- Enter the **show startup-config** command to display the passwords.
  - Recover or replace the displayed passwords.
  - Change the configuration register back to its original setting.

Note To recover a lost password if Break is disabled on the RPM, you must have physical access to the RPM.

Password Recovery Procedure

Complete the following steps to recover or replace a lost enable, enable secret, or console login password.

Step 1 Attach an ASCII terminal to the console port on your RPM.

Step 2 Configure the terminal to operate at 9600 baud, 8 data bits, no parity, and 2 stop bits.

Step 3 If you can log in to the RPM as a nonprivileged user, enter the **show version** command to display the existing configuration register value. Note the value for use later. If you cannot log in to the RPM at all, go to the next step.

Step 4 Press the **Break** key or send a Break from the console terminal.

If Break is enabled, the RPM enters the ROM monitor, indicated by the ROM monitor prompt (`rommon1>`). Proceed to Step 6.

If Break is disabled, power cycle the RPM (turn the RPM off or unplug the power cord, and then restore power). Then proceed to Step 5.

Step 5 Within 60 seconds of restoring the power to the RPM, press the **Break** key or send a Break. This action causes the RPM to enter the ROM monitor and display the ROM monitor prompt (`rommon1>`).

Step 6 To set the configuration register on a RPM, use the configuration register utility by entering the **confreg** command at the ROM monitor prompt, as follows.

```
rommon1> confreg
```

Answer **yes** to the enable "ignore system config info"? question and note the current configuration register settings.

Step 7 Initialize the RPM by entering the **reset** command as follows: `rommon2>` **reset**

The RPM will initialize, the configuration register will be set to 0x142, and the RPM will boot the system image from Flash memory and enter the system configuration dialog (setup), as follows.

```
--- System Configuration Dialog --
```

Step 8 Enter **no** in response to the system configuration dialog prompts until the following message is displayed:

```
Press RETURN to get started!
```

Step 9 Press **Return**. The user EXEC prompt is displayed as follows:

```
RPM>
```

Step 10 Enter the **enable** command to enter the privileged EXEC mode. Then enter the **show startup-config** command to display the passwords in the configuration file, as follows.

```
RPM# show startup-config
```

Step 11 Scan the configuration file display looking for the passwords (the enable passwords are usually near the beginning of the file, and the console login or user EXEC password is near the end). The passwords displayed will look something like this:

```
enable secret 5 $1$ORPP$s9syZt4uKn3SnpuLDrhuei
enable password 23skiddoo
.
.
line con 0
 password onramp
```

The enable secret password is encrypted and cannot be recovered; it must be replaced. The enable and console passwords may be encrypted or clear text. Proceed to the next step to replace an enable secret, console login, or enable password. If there is no enable secret password, note the enable and console login passwords if they are not encrypted and proceed to Step 16.

Caution *Do not* execute the next step unless you determine you must change or replace the enable, enable secret, or console login passwords. Failure to follow the steps as shown may cause you to erase your RPM configuration.

Step 12 Enter the **configure memory** command to load the startup configuration file into running memory. This action allows you to modify or replace passwords in the configuration.

```
RPM# configure memory
```

Step 13 Enter the privileged EXEC command **configure terminal** to enter configuration mode.

```
Hostname# configure terminal
```

Step 14 To change all three passwords, enter the following commands.

```
Hostname(config)# enable secret newpassword1
Hostname(config)# enable password newpassword2
Hostname(config)# line con 0
Hostname(config-line)# password newpassword3
```

Change only the passwords necessary for your configuration. You can remove individual passwords by using the **no** form of the above commands. For example, entering the **no enable secret** command will remove the enable secret password.

Step 15 You must configure all interfaces to be not administratively shutdown, as follows.

```
Hostname(config)# interface fastethernet 0/0
Hostname(config-int)# no shutdown
```

Enter the equivalent commands for all interfaces that were originally configured. If you omit this step, all interfaces will be administratively shutdown and unavailable when the RPM is restarted.

Step 16 Use the **config-register** command to set the configuration register to the original value noted in Step 3 or Step 7, or to the factory default value 0x2102, as follows.

```
Hostname(config)# config-register 0x2102
```

Step 17 Press **Ctrl-Z** or enter **end** to exit configuration mode and return to the EXEC command interpreter.

Caution *Do not* execute the next step unless you have changed or replaced a password. If you skipped Step 12 through Step 15, skip to Step 19. Failure to observe this caution will cause you to erase your RPM configuration file.

Step 18 Enter the **copy running-config startup-config** command to save the new configuration to nonvolatile memory.

Step 19 Enter the **reload** command to reboot the RPM.

Step 20 Log in to the RPM with the new or recovered passwords.

This completes the steps for recovering or replacing a lost enable, enable secret, or console login password.

Virtual Configuration Register Settings

The RPM has a 16-bit virtual configuration register, which is written into NVRAM. You might want to change the virtual configuration register settings for the following reasons:

- Set and display the configuration register value.
- Force the system into the ROM monitor or boot ROM.
- Select a boot source and default boot filename.
- Enable or disable the Break function.
- Control broadcast addresses.
- Set the console terminal baud rate.
- Recover a lost password (ignore the configuration file in NVRAM).
- Enable Trivial File Transfer Protocol (TFTP) server boot.

Table A-2 lists the meaning of each of the virtual configuration memory bits and defines the boot field names.

Caution To avoid confusion and possibly halting the RPM, remember that valid configuration register settings might be combinations of settings and not just the individual settings listed in Table A-2. For example, the factory default value of 0x2102 is a combination of settings.

Table A-2 Virtual Configuration Register Bit Meaning

Bit No.[1]	Hexadecimal	Meaning
00–03	0x0000–0x000F	Boot field
06	0x0040	Causes system software to ignore the contents of NVRAM (startup-config)
07	0x0080	OEM bit is enabled
08	0x0100	Break is disabled
10	0x0400	IP broadcast with all zeros
11–12	0x0800–0x1000	Console line speed
13	0x2000	Load the boot ROM software if a Flash boot fails five times
14	0x4000	IP broadcasts do not have network numbers
15	0x8000	Enable diagnostic messages and ignore the contents of NVRAM

1. The factory default value for the configuration register is 0x2102. This value is a combination of the following: bit 13 = 0x2000, bit 8 = 0x0100, and bits 00 through 03 = 0x0002.

Changing Configuration Register Settings

Perform the following steps to change the configuration register while running Cisco IOS software.

Step 1 Enter the **enable** command and your password to enter privileged mode.

```
MGX 8850-RPM> enable
password: enablepassword
MGX 8850-RPM#
```

Step 2 Enter the **configure terminal** command at the privileged-level system prompt (#).

```
MGX 8850-RPM# configure terminal
```

Step 3 To set the contents of the configuration register, enter the configuration command **config-register** *value*, where *value* is a hexadecimal number preceded by 0x (refer to Table A-2 and Table A-3).

```
MGX 8850-RPM(config)# config-register 0xvalue
```

(The virtual configuration register is stored in NVRAM.)

Table A-3 Explanation of Boot Field (Configuration Register Bits 00 to 03)

Boot Field	Boot Process
0x0	Stops the boot process in the ROM monitor.
0x1	Stops the boot process in the boot ROM monitor.
0x2	Full boot process, which loads the Cisco IOS image in Flash memory.
0x3–0xF	Specifies a default filename for booting over the network from a TFTP server. Enables boot system commands that override the default filename for booting over the network from a TFTP server.

Step 4 Press **Ctrl-Z** to exit configuration mode.

The new settings will be saved to memory; however, the new settings are not effective until the system software is reloaded by rebooting the RPM.

Step 5 To display the configuration register value currently in effect and the value that will be used at the next reload, enter the **show version** EXEC command. The value displays on the last line of the screen display:

```
Configuration register is 0x142 (will be 0x102 at next reload)
```

Step 6 Reboot the RPM.

The new value takes effect. Configuration register changes take effect only when the RPM restarts, which occurs when you turn the system on, or when you enter the **reload** command.

Virtual Configuration Register Bit Meanings

The lowest four bits of the virtual configuration register (bits 3, 2, 1, and 0) form the boot field (see Table A-3). The boot field specifies a number in binary form. If you set the boot field value to 0, you must boot the operating system manually by entering the **b** command at the bootstrap prompt, as follows:

```
> b [ tftp ] flash filename
```

The **b** command options are as follows:

- **b**—Boots the default system software from ROM
- **b flash**—Boots the first file in Flash memory

- **b** *filename [host]*—Boots from the network using a TFTP server
- **b flash** *[filename]*—Boots the file *filename* from Flash memory

For more information about the command **b [tftp] flash** *filename*, refer to the Cisco IOS configuration publications.

If you set the boot field value to a value of 0x2 through 0xF, and a valid system boot command is stored in the configuration file, the RPM boots the system software as directed by that value. If you set the boot field to any other bit pattern, the RPM uses the resulting number to form a default boot filename for booting from the network using a TFTP server (see Table A-4).

Table A-4 Default Boot Filenames

Filename	Bit 3	Bit 2	Bit 1	Bit 0
bootstrap mode	0	0	0	0
ROM software	0	0	0	1
cisco2-igs	0	0	1	0
cisco3-igs	0	0	1	1
cisco4-igs	0	1	0	0
cisco5-igs	0	1	0	1
cisco6-igs	0	1	1	0
cisco7-igs	0	1	1	1
cisco10-igs	1	0	0	0
cisco11-igs	1	0	0	1
cisco12-igs	1	0	1	0
cisco13-igs	1	0	1	1
cisco14-igs	1	1	0	0
cisco15-igs	1	1	0	1
cisco16-igs	1	1	1	0
cisco17-igs	1	1	1	1

In the following example, the virtual configuration register is set to boot the RPM from Flash memory and to ignore Break at the next reboot of the RPM.

```
MGX 8850-RPM> enable
password: enablepassword
MGX 8850-RPM# conf term
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
config-register 0x102
boot system flash [filename]
^Z
MGX 8850-RPM#
```

The RPM creates a default boot filename as part of the automatic configuration processes. The boot filename consists of *cisco* plus the octal equivalent of the boot field number, a hyphen, and the processor type.

Note A **boot system** configuration command in the RPM configuration in NVRAM overrides the default boot filename.

Bit 8 controls the console Break key. Setting bit 8 (the factory default) causes the processor to ignore the console Break key. Clearing bit 8 causes the processor to interpret the Break key as a command to force the system into the bootstrap monitor, thereby halting normal operation. A break can be sent in the first 60 seconds while the system reboots, regardless of the configuration settings.

Bit 10 controls the host portion of the IP broadcast address. Setting bit 10 causes the processor to use all zeros; clearing bit 10 (the factory default) causes the processor to use all ones. Bit 10 interacts with bit 14, which controls the network and subnet portions of the broadcast address (see Table A-5).

Table A-5 Configuration Register Settings for Broadcast Address Destination

Bit 14	Bit 10	Address (<net > <host>)
Off	Off	<ones> <ones>
Off	On	<zeros> <zeros>
On	On	<net> <zeros>
On	Off	<net> <ones>

Bits 11 and 12 in the configuration register determine the baud rate of the console terminal. Table A-6 shows the bit settings for the four available baud rates. (The factory-set default baud rate is 9600.)

Table A-6 System Console Terminal Baud Rate Settings

Baud	Bit 12	Bit 11
9600	0	0
4800	0	1
1200	1	0
2400	1	1

Bit 13 determines the server response to a bootload failure. Setting bit 13 causes the server to load operating software from ROM after five unsuccessful attempts to load a boot file from the network. Clearing bit 13 causes the server to continue attempting to load a boot file from the network indefinitely. By factory default, bit 13 is set to 1.

Enabling Booting from Flash Memory

To disable Break and enable the **boot system flash** command, enter the **config-register** command with the value shown in the following example:

```
MGX 8850-RPM> enable
Password: enablepassword
MGX 8850-RPM# config tRPM
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
```

```
config-reg 0x2102
^Z
MGX 8850-RPM#
```

Copying a Cisco IOS Image to Flash Memory

You may need to copy a new Cisco IOS image to Flash memory whenever a new image or maintenance release becomes available. Enter the **copy tftp flash** command for the copy procedure.

Perform the following steps to copy a new image to Flash memory from a TFTP server.

Step 1 Enter the **show flash** command to ensure that there is enough space available before copying a file to Flash memory. Compare the size of the file you want to copy to the amount of available Flash memory displayed.

Step 2 Make a backup copy of the current image. Enter **enable** mode and then enter the **copy flash tftp** command. Ensure that the filename of the current image is different from the new image so that you do not overwrite it.

Step 3 Enter the **copy tftp flash** command to copy the new image into Flash memory:

```
MGX 8850-RPM> enable
Password: enablepassword
MGX 8850-RPM# copy tftp flash
```

The following message displays:

```
                        ****  NOTICE  ****
Flash load helper vX.0
This process will accept the copy options and then terminate
the current system image to use the ROM based image for the copy.
Routing functionality will not be available during that time.
If you are logged in via telnet, this connection will terminate.
Users with console access can see the results of the copy operation.
                         ---- ******** ----
Proceed? [confirm]
```

Step 4 Press **Return** to confirm.

If there is an image already in Flash memory, the RPM displays the name and size of the file. The RPM prompts you for the IP address or name of the remote host.

```
Address or name of remote host [hostname]?
```

The remote host can be a server or another RPM with a valid Flash system software image.

Step 5 Enter the IP address or name of the remote host. The RPM then prompts you for the name of the source file.

```
Source file name?
```

Step 6 Enter the name of the source file. The following prompt displays:

```
Destination file name [filename]?
```

Step 7 Press **Return** to accept the default filename or enter a different filename. Messages similar to the following ones display.

```
Accessing file 'master/igs-j-l.110-4.2' on hostname...
Loading master/igs-j-l.110-4.2 from 172.16.72.1 (via Ethernet0): ! [OK]
```

```
Erase flash device before writing? [confirm] yes
```

Step 8 Enter **yes** to erase the contents of Flash memory. The following message displays.

```
Flash contains files. Are you sure you want to erase? [confirm] yes
```

Step 9 Enter **yes** to confirm that you want to erase the contents of Flash memory. Messages similar to the following display.

```
%SYS-5-RELOAD: Reload requested

%FLH: master/igs-j-l.110-4.2 from 172.16.72.1 to flash ...

System flash directory:
File  Length   Name/status
  1   3459776 username/igs-i-l
[3459840 bytes used, 4928768 available, 8388608 total]Configuration mapped ip address
172.16.72.1 to hostname
Accessing file 'master/igs-j-l.110-4.2' on hostname...
Loading master/igs-j-l.110-4.2 from 172.16.72.1 (via Ethernet0): ! [OK]

Erasing device... eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee ...erased
Loading master/igs-j-l.110-4.2 from 172.16.72.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 6196336/8388608 bytes]

Verifying checksum...  OK (0x2997)
Flash copy took 0:03:38 [hh:mm:ss]
%FLH: Re-booting system after download
```

The system reboots using the new image in Flash memory.

Note For more information on the **copy tftp flash** command and other related commands, refer to the Cisco IOS command reference publications.

Cable and Connector Specifications

This appendix provides the following pinout information:

- Console and Auxiliary Port Signals and Pinouts
- MGX-RJ45-4E, -4E/B, and -FE Port Adapter Cable Pinouts
- Fast Ethernet MII Port Adapter Pinouts
- FDDI Optical Bypass Switch Pinouts (for RPM/B)

Note All pins not listed in the tables in this appendix are not connected.

Note Cisco Systems does not provide 4E, FE, and FDDI port adapter cables. These cables must be ordered from outside commercial cable vendors. Cisco Systems does not provide console and auxiliary cables in the kit. Console and auxiliary cables can be ordered as spares from Cisco Systems.

Console and Auxiliary Port Signals and Pinouts

The RPM requires console and auxiliary cables so you can connect a console (an ASCII terminal or PC running terminal emulation software) or modem to your RPM. Cisco Systems does not provide these items. You will need the following items:

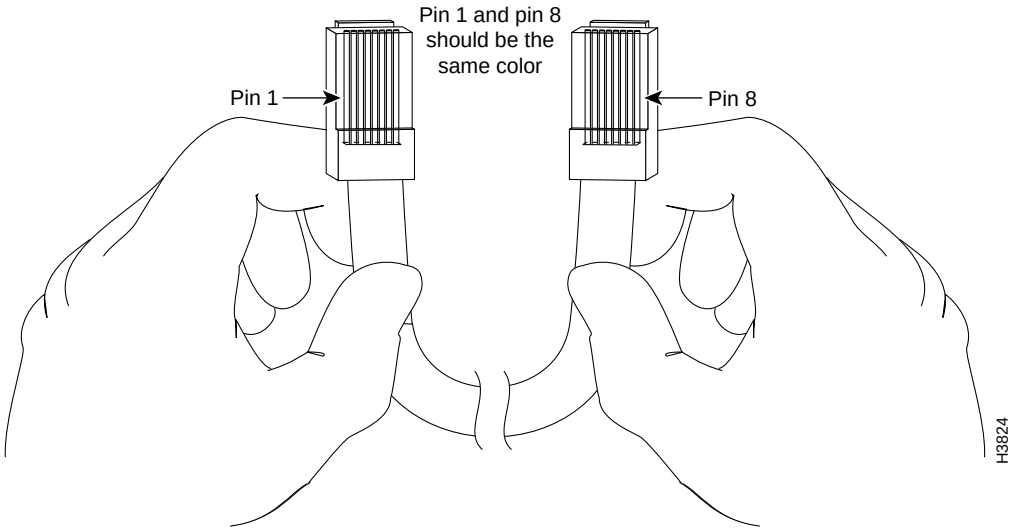
- Standard RJ-45-to-RJ-45 rollover cable (see the next section, “Identifying a Rollover Cable” for more information)
- Cable adapters
  - RJ-45-to-DB-9 female DTE adapter (labeled Terminal)
  - RJ-45-to-DB-25 female DTE adapter (labeled Terminal)
  - RJ-45-to-DB-25 male DCE adapter (labeled Modem)

For console connections, proceed to the “Console Port Signals and Pinouts” section later in this appendix; for modem connections, proceed to the “Auxiliary Port Signals and Pinouts” section later in this appendix.

Identifying a Rollover Cable

You can identify a rollover cable by comparing the two modular ends of the cable. Holding the cables side-by-side, with the tab at the back, the wire connected to the pin on the outside of the left plug should be the same color as the wire connected to the pin on the outside of the right plug (see Figure B-1). If your cable was purchased from Cisco Systems, pin 1 will be white on one connector, and pin 8 will be white on the other (a rollover cable reverses pins 1 and 8, 2 and 7, 3 and 6, and 4 and 5).

Figure B-1 Identifying a Rollover Cable



Console Port Signals and Pinouts

Use the thin, flat RJ-45-to-RJ-45 rollover cable and RJ-45-to-DB-9 female DTE adapter (labeled Terminal) to connect the console port to a PC running terminal emulation software. Figure B-2 shows how to connect the console port to a PC. Table B-1 lists the pinouts for the asynchronous serial console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-9 female DTE adapter (labeled Terminal).

Figure B-2 Connecting the Console Port to a PC

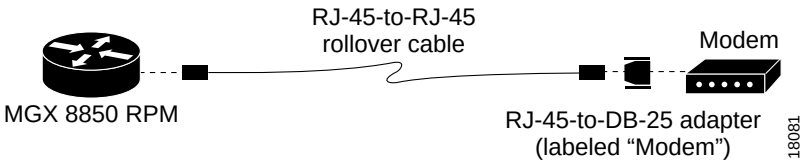


Table B-1 Console Port Signaling and Cabling Using a DB-9 Adapter

RPM Console Port (DTE)	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-9 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-9 Pin**	**Signal**
RTS	1[1]	8	8	CTS
DTR	2	7	6	DSR
TxD	3	6	2	RxD
GND	4	5	5	GND
GND	5	4	5	GND
RxD	6	3	3	TxD
DSR	7	2	4	DTR
CTS	8	1	7	RTS

1. Pin 1 is connected internally to pin 8.

Note This cabling configuration can also be used to connect a PC with the auxiliary port.

Use the thin, flat RJ-45-to-RJ-45 rollover cable and RJ-45-to-DB-25 female DTE adapter (labeled Terminal) to connect the console port to a terminal. Figure B-3 shows how to connect the console port to a terminal. Table B-2 lists the pinouts for the asynchronous serial console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-25 female DTE adapter (labeled Terminal).

Figure B-3 Connecting the Console Port to a Terminal

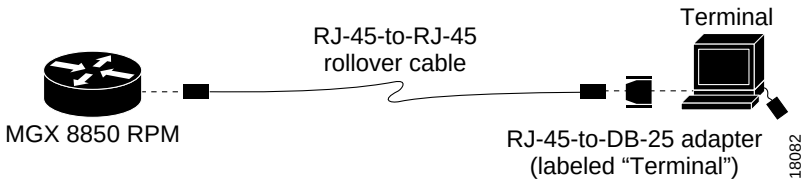


Table B-2 Console Port Signaling and Cabling Using a DB-25 Adapter

RPM Console Port (DTE)	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
RTS	1[1]	8	5	CTS
DTR	2	7	6	DSR
TxD	3	6	3	RxD
GND	4	5	7	GND
GND	5	4	7	GND
RxD	6	3	2	TxD

Table B-2 Console Port Signaling and Cabling Using a DB-25 Adapter (continued)

RPM Console Port (DTE)	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
DSR	7	2	20	DTR
CTS	8	1	4	RTS

1. Pin 1 is connected internally to pin 8.

Note This cabling configuration can also be used to connect a terminal with the auxiliary port.

Auxiliary Port Signals and Pinouts

Use the thin, flat RJ-45-to-RJ-45 rollover cable and RJ-45-to-DB-25 male DCE adapter (labeled Modem) to connect the auxiliary port to a modem. Figure B-4 shows how to connect the auxiliary port to a modem. Table B-3 lists the pinouts for the asynchronous serial auxiliary port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-25 male DCE adapter (labeled Modem).

Figure B-4 Connecting the Auxiliary Port to a Modem

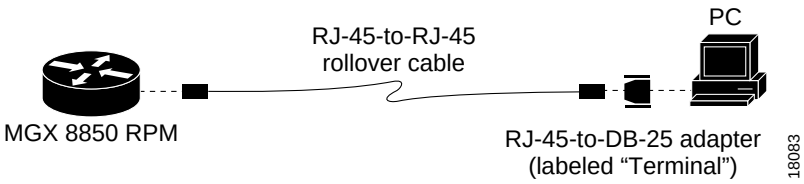


Table B-3 Auxiliary Port Signaling and Cabling Using a DB-25 Adapter

RPM Auxiliary Port (DTE)	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Modem Adapter	Modem
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
RTS	1	8	4	RTS
DTR	2	7	20	DTR
TxD	3	6	3	TxD
GND	4	5	7	GND
GND	5	4	7	GND
RxD	6	3	2	RxD
DSR	7	2	8	DCD
CTS	8	1	5	CTS

MGX-RJ45-4E, -4E/B, and -FE Port Adapter Cable Pinouts

Table B-4 provides pinouts for the 4E RJ-45 connector.

Note Cisco Systems does not provide 4E, 4E/B, or FE port adapter cables. These cables must be ordered from commercial cable vendors.

Table B-44E or 4E/B RJ-45 Connector Pinout

Pin	Description
1	Receive Data + (RxD+)
2	RxD–
3	Transmit Data + (TxD+)
6	TxD–

Note Referring to the RJ-45 pinout in Table B-4, proper common-mode line terminations should be used for the unused Category 5, UTP cable pairs 4/5 and 7/8. Common-mode termination reduces the contributions to electromagnetic interference (EMI) and susceptibility to common-mode sources. Wire pairs 4/5 and 7/8 are actively terminated in the RJ-45 port circuitry in the 4E and 4E/B port adapter and in the 100BaseTX port circuitry in the FE-TX port adapter.

Depending on your RJ-45 interface cabling requirements, use the pinouts in Figure B-5 and Figure B-6.

Figure B-5 Straight-Through Cable Pinout, 4E, 4E/B, or FE-TX RJ-45 Connection to a Hub or Repeater

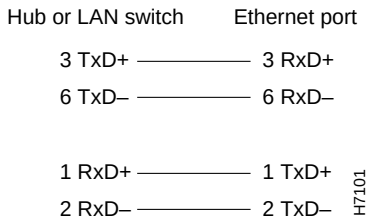
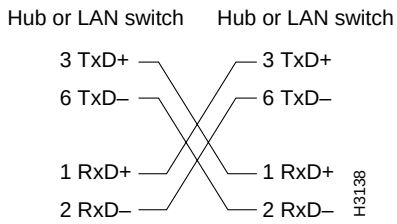


Figure B-6 Crossover Cable Pinout, 4E, 4E/B, or FE-TX RJ-45 Connections Between Hubs and Repeaters



Fast Ethernet MII Port Adapter Pinouts

Table B-5 provides pinouts for the fast ethernet MII RJ-45 connector.

Table B-5 MII Connector Pinout

Pin[1]	In	Out	In/Out	Description
14–17	–	Yes	–	Transmit Data (TxD)
12	Yes	–	–	Transmit Clock (Tx_CLK)[2]
11	–	Yes	–	Transmit Error (Tx_ER)
13	–	Yes	–	Transmit Enable (Tx_EN)
3	–	Yes	–	MII Data Clock (MDC)
4–7	Yes	–	–	Receive Data (RxD)
9	Yes	–	–	Receive Clock (Rx_CLK)
10	Yes	–	–	Receive Error (Rx_ER)
8	Yes	–	–	Receive Data Valid (Rx_DV)
18	Yes	–	–	Collision (COL)
19	Yes	–	–	Carrier Sense (CRS)
2	–	–	Yes	MII Data Input/Output (MDIO)
22–39	–	–	–	Common (ground)
1, 20, 21, 40	–	–	–	+5.0 volts (V)

1. Any pins not indicated are not used.
2. Tx_CLK and Rx_CLK are generated by the external transceiver.

FDDI Optical Bypass Switch Pinouts (for RPM/B)

Table B-6 lists the signal descriptions for the mini-DIN optical bypass switch available on the FDDI port adapters. The mini-DIN-to-DIN adapter cable (CAB-FMDD=) allows a connection to an optical bypass switch with a DIN connector (which is larger than the mini-DIN connector on the FDDI port adapters).

Table B-6 Optical Bypass Switch Pinout

Pin	Direction	Description
1	Out	+5V to secondary switch
2	Out	+5V to primary switch
3	Out	Enable optical bypass switch primary
4	Out	Enable optical bypass switch secondary
5	In	Sense optical bypass switch—1000 ohm to +5V
6	Out	Ground—Sense optical bypass switch return

Note Cisco Systems does not provide FDDI port adapter cables. These cables must be ordered from commercial cable vendors.

IOS and Configuration Basics

This appendix contains basic information about the Cisco Internet Operating System (IOS) software and includes the following sections:

- Cisco IOS Modes of Operation
- Getting Context-Sensitive Help
- Saving Configuration Changes

Cisco IOS Modes of Operation

Cisco IOS software provides access to several different command modes. Each command mode provides a different group of related commands.

For security purposes, Cisco IOS software provides two levels of access to commands: user and privileged. The unprivileged user mode is called user EXEC mode. The privileged mode is called privileged EXEC mode and requires a password. The commands available in user EXEC mode are a subset of the commands available in privileged EXEC mode.

Table C-1 describes some of the most commonly used modes, how to enter the modes, and the resulting prompts. The prompt helps you identify which mode you are in and, therefore, which commands are available to you.

Table C-1 Cisco IOS Operating Modes

Mode of Operation	Usage	How to Enter the Mode	Prompt
User EXEC	User EXEC commands allow you to connect to remote devices, change terminal settings on a temporary basis, perform basic tests, and list system information. The EXEC commands available at the user level are a subset of those available at the privileged level.	Log in.	MGX8850-RPM>
Privileged EXEC	Privileged EXEC commands set operating parameters. The privileged command set includes those commands contained in user EXEC mode, and also the **configure** command through which you can access the remaining command modes. Privileged EXEC mode also includes high-level testing commands, such as **debug**.	Enter the **enable** EXEC command from user EXEC mode.	MGX8850-RPM#
Global configuration	Global configuration commands apply to features that affect the system as a whole.	Enter the **configure** privileged EXEC command from global configuration mode.	MGX8850-RPM(config)#
Interface configuration	Interface configuration commands modify the operation of an interface such as an Ethernet or serial port. Many features are enabled on a per-interface basis. Interface configuration commands always follow an interface global configuration command, which defines the interface type.	Enter the **interface** *type number* command from global configuration mode. For example, enter the **interface int switch 9/1** command to configure the ATM interface.	MGX8850-RPM(config-if)#
ROM monitor	ROM monitor commands are used to perform low-level diagnostics. You can also use the ROM monitor commands to recover from a system failure and stop the boot process in a specific operating environment.[1]	Enter the **reload** EXEC command from privileged EXEC mode. Click **BREAK** during the first 60 seconds while the system is booting.	ROMMON>

1. You can modify the configuration register value using the **config-reg** configuration command. See Appendix A, “Maintaining the MGX RPM” the “Virtual Configuration Register Settings” section for more information.

Almost every configuration command also has a **no** form. In general, use the **no** form to disable a feature or function. Use the command without the keyword **no** to reenable a disabled feature or to enable a feature that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, enter the **no ip routing** command and enter **ip routing** to reenable it. The Cisco IOS software command reference publication provides the complete syntax for the configuration commands and describes what the **no** form of a command does.

Getting Context-Sensitive Help

In any command mode, you can list the available commands by entering a question mark (**?**).

```
MGX8850-RPM> ?
```

To obtain a list of commands that begin with a particular character sequence, type in those characters followed immediately by the question mark (**?**). Do not include a space. This form of help is called word help because it completes a word for you.

```
MGX8850-RPM# co?
configure  connect  copy
```

To list keywords or arguments, enter a question mark in place of a keyword or argument. Include a space before the question mark. This form of help is called command syntax help, because it reminds you which keywords or arguments are applicable, based on the commands, keywords, and arguments you have already entered.

```
MGX8850-RPM# configure ?
  memory    Configure from NV memory
  network   Configure from a TFTP network host
  terminal  Configure from the terminal
  <cr>
```

You can also abbreviate commands and keywords by entering just enough characters to make the command unique from other commands. For example, you can abbreviate the **show** command to **sh**.

Saving Configuration Changes

Whenever you make changes to the RPM configuration, you must save the changes to memory so they will not be lost if the system is rebooted. There are two types of configuration files: the running (current operating) configuration and the startup configuration. The running configuration is stored in RAM; the startup configuration is stored in NVRAM.

To display the current running configuration, enter the **show running-config** command. Enter the **copy running-config startup-config** command to save the current running configuration to the startup configuration file in NVRAM.

```
MGX8850-RPM> enable
MGX8850-RPM# copy running-config startup-config
```

To display the startup configuration, enter the **show startup-config** command. Enter the **copy startup-config running-config** command to write the startup configuration to the running configuration.

```
MGX8850-RPM> enable
MGX8850-RPM# copy startup-config running-config
```

To erase both configuration files (and start over), enter the **write erase** and **reload** commands:

```
MGX8850-RPM> enable
MGX8850-RPM# write erase
MGX8850-RPM# reload
```

Warning **This command sequence will erase the entire RPM configuration in RAM and NVRAM and reload the RPM.**

Manually Configuring RPM

You can configure the RPM manually if you prefer not to use **AutoInstall** or the prompt-driven System Configuration Dialog.

Take the following steps to configure the RPM manually:

Step 1 Connect a console terminal to the RPM.

Follow the instructions described in Chapter 3, "Installing the MGX RPM," in the section "Connecting a Console Terminal or PC to the RPM Console Port," and then power on the RPM.

Step 2 When you are prompted to enter the initial dialog, enter **no** to go into the normal operating mode of the RPM:

```
Would you like to enter the initial dialog? [yes]: no
```

Step 3 After a few seconds you will see the user EXEC prompt (Router>).

By default, the host name is Router, but the prompt will match the current host name. In the following examples, the host name is MGX8850-RPM. Enter the **enable** command to enter enable mode. You can make configuration changes only in enable mode:

```
MGX8850-RPM> enable
```

The prompt will change to the privileged EXEC (enable) prompt, MGX8850-RPM#.

Step 4 Enter the **configure terminal** command at the enable prompt to enter configuration mode:

```
MGX8850-RPM# config terminal
```

You can now enter any changes you want to the configuration. You will probably want to perform the following tasks:

1. Assign a host name for the RPM using the **hostname** command.
2. Enter an enable secret using the **enable secret** command.
3. Enter an enable password using the **enable password** command.
4. Assign addresses to the interfaces using the **protocol address** command.
5. Specify which protocols to support on the interfaces.

Refer to the Cisco IOS configuration and command reference publications for more information about the commands you can use to configure the RPM. You can also refer to the *MGX 8850 Wide Area Switch Command Reference* and *MGX 8850 Wide Area Switch Installation and Configuration* documents for information about the commands you can use to configure the RPM.

Step 5 When you finish configuring the RPM, enter the **exit** command until you return to the privileged EXEC prompt (MGX8850-RPM#).

Step 6 To save the configuration changes to NVRAM, enter the **copy run start** command at the privileged EXEC prompt:

```
MGX8850-RPM# copy run start
********
```

The RPM is now configured and will boot with the configuration you entered.

This concludes the initial RPM configuration.

Verifying Network Connectivity

When you have installed and configured the RPM, you can use the following commands in user EXEC mode to verify network connectivity:

- **ping**—Sends a special datagram to the destination device, then waits for a reply datagram from that device
  See "Verifying Network Connectivity" of Chapter 5 in this manual for a detailed **ping** procedure.
- **telnet**—Logs in to a remote node
- **traceroute**—Discovers the routes that packets take when traveling from one RPM to another

If there is a problem with network connectivity, see Appendix A, "Maintaining the MGX RPM" in the section "Reading Front Panel LEDs," and check the cable connections. If there is still a problem, check the RPM configuration. Contact customer service for further assistance.