Cisco 1800 Series Integrated Services Routers (Fixed) Software Configuration Guide

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Cisco 1800 Series Integrated Services Routers (Fixed) Software Configuration Guide

CONTENTS

Preface

This software configuration guide provides instructions for using the Cisco command-line interface (CLI) to configure features of the following Cisco 1800 series integrated services fixed-configuration routers:

- Cisco 1801, Cisco 1802, and Cisco 1803 DSL Access Routers
- Cisco 1811 and Cisco 1812 Ethernet Access Routers

This preface describes the intended audience, the organization of this guide, and the text and command conventions used throughout the guide. The preface includes the following topics:

Audience

This guide is intended for network administrators whose backgrounds vary from having no or little experience in configuring routers to having a high level of experience. You can use this guide in the following situations:

- You have configured the software by using the Cisco Router Web Setup tool, and you want to configure additional advanced software features by using the command-line interface (CLI).
- You want to configure the software using only the CLI.

Note We strongly recommend that network administrators with minimal familiarity with Cisco routers use the Cisco Router and Security Device Manager (SDM)—a web-based configuration tool that allows you to configure LAN and WAN interfaces, routing, Network Address Translation (NAT), firewalls, VPNs, and other features on your router. To obtain the SDM release notes and other SDM documentation, go to http://www.cisco.com/go/sdm and click the **Technical Documentation** link.

See the "Organization" section of this preface to help you decide which chapters contain the information you need to configure your router.

Organization

Table 1 lists the topics covered by this guide.

Table 1 Document Organization

Chapter	Title	Description
Part 1: Getting Started		
Chapter 1	Basic Router Configuration	Describes how to configure basic router features and interfaces.
Part 2: Configuring Your Router for Ethernet and DSL Access		
Chapter 2	Sample Network Deployments	Provides a road map for Part 2.
Chapter 3	Configuring PPP over Ethernet with NAT	Provides instructions on how to configure PPPoE with Network Address Translation (NAT) on your Cisco router.
Chapter 4	Configuring PPP over ATM with NAT	Provides instructions on how to configure PPPoA with Network Address Translation (NAT) on your Cisco router.
Chapter 5	Configuring a LAN with DHCP and VLANs	Provides instructions on how to configure your Cisco router with multiple VLANs and to act as a DHCP server.
Chapter 6	Configuring a VPN Using Easy VPN and an IPSec Tunnel	Provides instructions on how to configure a virtual private network (VPN) with a secure IP tunnel using the Cisco Easy VPN.
Chapter 7	Configuring VPNs Using an IPSec Tunnel and Generic Routing Encapsulation	Provides instructions on how to configure a VPN with a secure IP tunnel and generic routing encapsulation (GRE).
Chapter 8	Configuring a Simple Firewall	Provides instructions on how to configure a basic firewall on your Cisco router.
Chapter 9	Configuring a Wireless LAN Connection	Provides instructions on how to configure a wireless LAN.
Chapter 10	Sample Configuration	Presents a summary configuration example showing features configured in the preceding chapters of this part of the guide.
Part 3:Configuring Additional Features and Troubleshooting		
Chapter 11	Additional Configuration Options	Provides a road map for Part 3.
Chapter 12	Configuring Security Features	Explains basic configuration of Cisco IOS security features, including firewall and VPN configuration.
Chapter 13	Configuring Dial Backup and Remote Management	Provides instructions on how to configure your Cisco router for dial backup and remote management.
Chapter 14	Troubleshooting	Provides information on identifying and solving problems, such as how to recover a lost software password.
Part 4: Reference Information		
Appendix A	Cisco IOS Software Basic Skills	Explains what you need to know about Cisco IOS software before you begin to configure it.
Appendix B	Concepts	Provides general concept explanations of features.

Table 1 Document Organization (continued)

Chapter	Title	Description
Appendix C	ROM Monitor	Describes the use of the ROM Monitor (ROMMON) utility.
Appendix D	Common Port Assignments	Describes the currently assigned Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) port numbers.
Index		

Conventions

This guide uses the conventions described in the following sections for instructions and information.

Notes, Cautions, and Timesavers

Notes, cautions and time-saving tips use the following conventions and symbols:

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

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

Timesaver This symbol means *the described action saves time*.

Command Conventions

Table 2 describes the command syntax used in this guide.

Table 2 Command Syntax Conventions

Convention	Description
boldface	Commands and keywords.
italic	Command input that is supplied by you.
[ ]	Optional keywords and default responses to system prompts appear within square brackets.
{**x** | **x** | **x**}	A choice of keywords (represented by **x**) appears in braces separated by vertical bars. You must select one.

Table 2 Command Syntax Conventions (continued)

Convention	Description
^ or Ctrl	Represents the key labeled *Control*. For example, when you read ^*D* or *Ctrl-D*, you should hold down the Control key while you press the D key.
`screen font`	Examples of information displayed on the screen.
`boldface screen font`	Examples of information that you must enter.

Related Documents

Table 3 lists publications that provide related information on these routers:

Table 3 Related and Referenced Documents

Cisco Product	Document Title
Cisco 1800 series fixed-configuration routers	*Cisco 1811 and Cisco 1812 Integrated Services Router Cabling and Installation*
	Cisco 1801, Cisco 1802, and Cisco 1803 Integrated Services Router Cabling and Installation
	Cisco 1800 Series Integrated Services Router (Fixed) Hardware Installation Guide
	Regulatory Compliance and Safety Information for Cisco 1800 Integrated Services Routers (Fixed)
	Cisco Modular Access Router Cable Specifications
Cisco access router wireless LAN documentation	*Cisco Access Router Wireless Configuration Guide*
	Cisco access router antenna documentation
	Declarations of Conformity and Regulatory Information for Cisco Access Products with 802.11a/b/g and 802.11b/g Radios
Network management system	*Cisco Router and Security Device Manager (SDM) Quick Start Guide*
	Network management software documentation
Cisco IOS software	Cisco IOS software documentation, all releases. See the documentation for the Cisco IOS software release installed on your router.

Obtaining Documentation

Cisco documentation and additional literature are available on Cisco.com. Cisco also provides several ways to obtain technical assistance and other technical resources. These sections explain how to obtain technical information from Cisco Systems.

Cisco.com

You can access the most current Cisco documentation at this URL:

http://www.cisco.com/univercd/home/home.htm

You can access the Cisco website at this URL:

http://www.cisco.com

You can access international Cisco websites at this URL:

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

Documentation DVD

Cisco documentation and additional literature are available in a Documentation DVD package, which may have shipped with your product. The Documentation DVD is updated regularly and may be more current than printed documentation. The Documentation DVD package is available as a single unit.

Registered Cisco.com users (Cisco direct customers) can order a Cisco Documentation DVD (product number DOC-DOCDVD=) from the Ordering tool or Cisco Marketplace.

Cisco Ordering tool:

http://www.cisco.com/en/US/partner/ordering/

Cisco Marketplace:

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

Ordering Documentation

You can find instructions for ordering documentation at this URL:

http://www.cisco.com/univercd/cc/td/doc/es_inpck/pdi.htm

You can order Cisco documentation in these ways:

- Registered Cisco.com users (Cisco direct customers) can order Cisco product documentation from the Ordering tool:

  http://www.cisco.com/en/US/partner/ordering/

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco Systems Corporate Headquarters (California, USA) at 408 526-7208 or, elsewhere in North America, by calling 1 800 553-NETS (6387).

Documentation Feedback

You can send comments about technical documentation to bug-doc@cisco.com.

You can submit comments by using the response card (if present) behind the front cover of your document or by writing to the following address:

Cisco Systems
Attn: Customer Document Ordering
170 West Tasman Drive
San Jose, CA 95134-9883

We appreciate your comments.

Cisco Product Security Overview

Cisco provides a free online Security Vulnerability Policy portal at this URL:

http://www.cisco.com/en/US/products/products_security_vulnerability_policy.html

From this site, you can perform these tasks:

- Report security vulnerabilities in Cisco products.
- Obtain assistance with security incidents that involve Cisco products.
- Register to receive security information from Cisco.

A current list of security advisories and notices for Cisco products is available at this URL:

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

If you prefer to see advisories and notices as they are updated in real time, you can access a Product Security Incident Response Team Really Simple Syndication (PSIRT RSS) feed from this URL:

http://www.cisco.com/en/US/products/products_psirt_rss_feed.html

Reporting Security Problems in Cisco Products

Cisco is committed to delivering secure products. We test our products internally before we release them, and we strive to correct all vulnerabilities quickly. If you think that you might have identified a vulnerability in a Cisco product, contact PSIRT:

- Emergencies—security-alert@cisco.com
- Nonemergencies—psirt@cisco.com

Tip We encourage you to use Pretty Good Privacy (PGP) or a compatible product to encrypt any sensitive information that you send to Cisco. PSIRT can work from encrypted information that is compatible with PGP versions 2.*x* through 8.*x*.

Never use a revoked or an expired encryption key. The correct public key to use in your correspondence with PSIRT is the one that has the most recent creation date in this public key server list:

http://pgp.mit.edu:11371/pks/lookup?search=psirt%40cisco.com&op=index&exact=on

In an emergency, you can also reach PSIRT by telephone:

- 1 877 228-7302
- 1 408 525-6532

Obtaining Technical Assistance

For all customers, partners, resellers, and distributors who hold valid Cisco service contracts, Cisco Technical Support provides 24-hour-a-day, award-winning technical assistance. The Cisco Technical Support Website on Cisco.com features extensive online support resources. In addition, Cisco Technical Assistance Center (TAC) engineers provide telephone support. If you do not hold a valid Cisco service contract, contact your reseller.

Cisco Technical Support Website

The Cisco Technical Support Website provides online documents and tools for troubleshooting and resolving technical issues with Cisco products and technologies. The website is available 24 hours a day, 365 days a year, at this URL:

http://www.cisco.com/techsupport

Access to all tools on the Cisco Technical Support Website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register at this URL:

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

Note Use the Cisco Product Identification (CPI) tool to locate your product serial number before submitting a web or phone request for service. You can access the CPI tool from the Cisco Technical Support Website by clicking the **Tools & Resources** link under Documentation & Tools. Choose **Cisco Product Identification Tool** from the Alphabetical Index drop-down list, or click the **Cisco Product Identification Tool** link under Alerts & RMAs. The CPI tool offers three search options: by product ID or model name; by tree view; or for certain products, by copying and pasting **show** command output. Search results show an illustration of your product with the serial number label location highlighted. Locate the serial number label on your product and record the information before placing a service call.

Submitting a Service Request

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

http://www.cisco.com/techsupport/servicerequest

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

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

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

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

http://www.cisco.com/techsupport/contacts

Definitions of Service Request Severity

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

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

Severity 2 (S2)—Operation of an existing network is severely degraded, or significant aspects of your business operation are negatively affected by inadequate performance of Cisco products. You and Cisco will commit full-time resources during normal business hours to resolve the situation.

Severity 3 (S3)—Operational performance of your network is impaired, but most business operations remain functional. You and Cisco will commit resources during normal business hours to restore service to satisfactory levels.

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

Obtaining Additional Publications and Information

Information about Cisco products, technologies, and network solutions is available from various online and printed sources.

- Cisco Marketplace provides a variety of Cisco books, reference guides, and logo merchandise. Visit Cisco Marketplace, the company store, at this URL:

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

- *Cisco Press* publishes a wide range of general networking, training and certification titles. Both new and experienced users will benefit from these publications. For current Cisco Press titles and other information, go to Cisco Press at this URL:

  http://www.ciscopress.com

- *Packet* magazine is the Cisco Systems technical user magazine for maximizing Internet and networking investments. Each quarter, Packet delivers coverage of the latest industry trends, technology breakthroughs, and Cisco products and solutions, as well as network deployment and troubleshooting tips, configuration examples, customer case studies, certification and training information, and links to scores of in-depth online resources. You can access Packet magazine at this URL:

  http://www.cisco.com/packet

- *iQ Magazine* is the quarterly publication from Cisco Systems designed to help growing companies learn how they can use technology to increase revenue, streamline their business, and expand services. The publication identifies the challenges facing these companies and the technologies to help solve them, using real-world case studies and business strategies to help readers make sound technology investment decisions. You can access iQ Magazine at this URL:

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

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

  http://www.cisco.com/ipj

- World-class networking training is available from Cisco. You can view current offerings at this URL:

  http://www.cisco.com/en/US/learning/index.html

PART 1

Getting Started

Basic Router Configuration

This chapter provides procedures for configuring the basic parameters of your Cisco router, including global parameter settings, routing protocols, interfaces, and command-line access. It also describes the default configuration on startup. Note that individual router models may not support every feature described throughout this guide. Features not supported by a particular router are indicated whenever possible.

This chapter contains the following sections:

Each section includes a configuration example and verification steps, as available.

For complete information on how to access global configuration mode, see the "Entering Global Configuration Mode" section in Appendix A, "Cisco IOS Basic Skills." For more information on the commands used in the following tables, see the Cisco IOS Release 12.3 documentation set.

Interface Port Labels

Table 1 lists the interfaces supported for each router and their associated port labels on the equipment.

Table 1 Supported Interfaces and Associated Port Labels by Cisco Router

Router	Interface	Port Label
Cisco 1801	Fast Ethernet LANs	SWITCH and FE8–FE5 (top), FE x and FE4–FE1 (bottom)
	Fast Ethernet WANs	FE0
	ATM WAN	ADSLoPOTS
	Wireless LAN	LEFT, RIGHT/PRIMARY
	BRI	ISDN S/T

Table 1 Supported Interfaces and Associated Port Labels by Cisco Router (continued)

Router	Interface	Port Label
Cisco 1802	Fast Ethernet LANs	SWITCH and FE8–FE5 (top), FE x and FE4–FE1 (bottom)
	Fast Ethernet WANs	FE0
	ATM WAN	ADSLoISDN
	Wireless LAN	LEFT, RIGHT/PRIMARY
	BRI	ISDN S/T
Cisco 1803	Fast Ethernet LANs	SWITCH and FE8–FE5 (top), FE x and FE4–FE1 (bottom)
	Fast Ethernet WANs	FE0
	ATM WAN	G.SHDSL
	Wireless LAN	LEFT, RIGHT/PRIMARY
	BRI	ISDN S/T
Cisco 1811	Fast Ethernet LANs	SWITCH and FE9–FE6 (top), FE x and FE5–FE2 (bottom)
	Fast Ethernet WANs	FE0–FE1
	Wireless LAN	LEFT, RIGHT/PRIMARY
	USB	1–0
	V.92	MODEM
Cisco 1812	Fast Ethernet LANs	SWITCH and FE9–FE6 (top), FE x and FE5–FE2 (bottom)
	Fast Ethernet WANs	FE0–FE1
	Wireless LAN	LEFT, RIGHT/PRIMARY
	BRI	ISDN S/T
	USB	1–0

Viewing the Default Configuration

When you first boot up your Cisco router, some basic configuration has already been performed. All of the LAN and WAN interfaces have been created, console and VTY ports are configured, and the inside interface for Network Address Translation has been assigned. Use the **show running-config** command to view the initial configuration, as shown in Example 1.

Note If you are unable to view the initial configuration and you get a No Password Set error message, you must reset the initial password. For details, see the "Recovering a Lost Password" section in Chapter 14, "Troubleshooting".

Example 1 Cisco 1812 Default Configuration on Startup

```
version 12.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
!
mmi polling-interval 60
no mmi auto-configure
no mmi pvc
mmi snmp-timeout 180
no aaa new-model
ip subnet-zero
!
ip cef
!
ip ips po max-events 100
no ftp-server write-enable
!
interface BRI0
 no ip address
 shutdown
!
interface FastEthernet0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet2
 no ip address
 shutdown
!
interface FastEthernet3
 no ip address
 shutdown
!
interface FastEthernet4
 no ip address
 shutdown
!
interface FastEthernet5
 no ip address
 shutdown
!
interface FastEthernet6
 no ip address
 shutdown
!
interface FastEthernet7
 no ip address
 shutdown
!
```

```
interface FastEthernet8
 no ip address
 shutdown
!
interface FastEthernet9
 no ip address
 shutdown
!
interface Vlan1
 no ip address
!
ip classless
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
line aux 0
line vty 0 4
!
no scheduler allocate
end
```

Information Needed for Configuration

You need to gather some or all of the following information, depending on your planned network scenario, prior to configuring your network

- If you are setting up an Internet connection, gather the following information:
  - Point-to-Point Protocol (PPP) client name that is assigned as your login name
  - PPP authentication type: Challenge Handshake Authentication Protocol (CHAP) or Password Authentication Protocol (PAP)
  - PPP password to access your Internet service provider (ISP) account
  - DNS server IP address and default gateways
- If you are setting up a connection to a corporate network, you and the network administrator must generate and share the following information for the WAN interfaces of the routers:
  - PPP authentication type: CHAP or PAP
  - PPP client name to access the router
  - PPP password to access the router
- If you are setting up IP routing:
  - Generate the addressing scheme for your IP network.
  - Determine the IP routing parameter information, including IP address, and ATM permanent virtual circuits (PVCs). These PVC parameters are typically virtual path identifier (VPI), virtual circuit identifier (VCI), and traffic shaping parameters.
  - Determine the number of PVCs that your service provider has given you, along with their VPIs and VCIs.
  - For each PVC determine the type of AAL5 encapsulation supported. It can be one of the following:

AAL5SNAP—This can be either routed RFC 1483 or bridged RFC 1483. For routed RFC 1483, the service provider must provide you with a static IP address. For bridged RFC 1483, you may use DHCP to obtain your IP address, or you may obtain a static IP address from your service provider.

AAL5MUX PPP—With this type of encapsulation, you need to determine the PPP-related configuration items.

- If you plan to connect over an ADSL or G.SHDSL line:
  - Order the appropriate line from your public telephone service provider.

    For ADSL lines—Ensure that the ADSL signaling type is DMT (also called ANSI T1.413) or DMT Issue 2.

    For G.SHDSL lines—Verify that the G.SHDSL line conforms to the ITU G.991.2 standard and supports Annex A (North America) or Annex B (Europe).

    Once you have collected the appropriate information, you can perform a full configuration on your router, beginning with the tasks in the "Configuring Basic Parameters" section.

Configuring Basic Parameters

To configure the router, perform one or more of these tasks:

- Configure Global Parameters
- Configure Fast Ethernet LAN Interfaces
- Configure WAN Interfaces
- Configuring a Loopback Interface
- Configuring Command-Line Access to the Router

A configuration example is presented with each task to show the network configuration following completion of that task.

Configure Global Parameters

Perform these steps to configure selected global parameters for your router:

	Command	Purpose

Step 1	**configure terminal**
	
	Example:
	`Router> enable`
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode, when using the console port.
		
		If you are connecting to the router using a remote terminal, use the following:
		`telnet router name or address`
		`Login: login id`
		`Password: *********`
		`Router> enable`

Step 2	**hostname** *name*
	
	Example:
	`Router(config)# hostname Router`
	`Router(config)#`
		Specifies the name for the router.

Step 3	**enable secret** *password*
	
	Example:
	`Router(config)# enable secret cr1ny5ho`
	`Router(config)#`
		Specifies an encrypted password to prevent unauthorized access to the router.

Step 4	**no ip domain-lookup**
	
	Example:
	`Router(config)# no ip domain-lookup`
	`Router(config)#`
		Disables the router from translating unfamiliar words (typos) into IP addresses.

For complete information on the global parameter commands, see the Cisco IOS Release 12.3 documentation set.

Configure Fast Ethernet LAN Interfaces

The Fast Ethernet LAN interfaces on your router are automatically configured as part of the default VLAN and as such, they are not configured with individual addresses. Access is afforded through the VLAN. You may assign the interfaces to other VLANs if desired. For more information about creating VLANs, see Chapter 5, “Configuring a LAN with DHCP and VLANs.”

Configure WAN Interfaces

The Cisco 1811 and Cisco 1812 routers each have two Fast Ethernet interfaces for WAN connection. The Cisco 1801, Cisco 1802, and Cisco 1803 routers each have one ATM interface for WAN connection.

Based on the router model you have, configure the WAN interface(s) using one of the following procedures:

- Configure the Fast Ethernet WAN Interface
- Configure the ATM WAN Interface

Configure the Fast Ethernet WAN Interface

This procedure applies only to the Cisco 1811 and Cisco 1812 router models. Perform these steps to configure the Fast Ethernet interfaces, beginning in global configuration mode.

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)#interface fastethernet 0`
	`Router(config-int)#`
		Enters the configuration mode for a Fast Ethernet WAN interface on the router.
		
		Note Fast Ethernet WAN ports are numbered 0–1 on the Cisco 1800 series routers.

Step 2	**ip address** *ip-address mask*
	
	Example:
	`Router(config-int)# ip address 192.1.12.2 255.255.255.0`
	`Router(config-int)#`
		Sets the IP address and subnet mask for the specified Fast Ethernet interface.

Step 3	**no shutdown**
	
	Example:
	`Router(config-int)# no shutdown`
	`Router(config-int)#`
		Enables the Ethernet interface, changing its state from administratively down to administratively up.

Step 4	**exit**
	
	Example:
	`Router(config-int)# exit`
	`Router(config)#`
		Exits interface configuration mode and returns to global configuration mode.

Repeat these steps for the other Fast Ethernet WAN interface if desired.

Configure the ATM WAN Interface

This procedure applies only to the Cisco 1801, Cisco 1802, and Cisco 1803 models.

Perform these steps to configure the ATM interface, beginning in global configuration mode:

	Command	Purpose

Step 1	***For the Cisco 1803 only:***
	controller dsl 0
	mode atm
	exit
	
	Example:
	`Router(config)# controller dsl 0`
	`Router(config-controller)# mode atm`
	`Router(config-controller)# exit`
	`Router(config)#`
		For routers using the G.SHDSL signaling, perform these commands. Ignore this step for routers using ADSL signaling.

Step 2	**interface** *type number*
	
	Example:
	`Router(config)# interface atm0`
	`Router(config-int)#`
		Enters interface configuration mode.

Step 3	**ip address** *ip-address mask*
	
	Example:
	`Router(config-int)# ip address 200.200.100.1 255.255.255.0`
	`Router(config-int)#`
		Sets the IP address and subnet mask for the ATM interface.

Step 4	**no shutdown**
	
	Example:
	`Router(config-int)# no shutdown`
	`Router(config-int)#`
		Enables the ATM 0 interface.

Step 5	**exit**
	
	Example:
	`Router(config-int)# exit`
	`Router(config)#`
		Exits interface configuration mode and returns to global configuration mode.

Configure the Wireless Interface

The wireless interface enables connection to the router through a wireless LAN connection. For more information about configuring a wireless connection, see Chapter 9, "Configuring a Wireless LAN Connection" and the *Cisco Access Router Wireless Configuration Guide*.

Configuring a Loopback Interface

The loopback interface acts as a placeholder for the static IP address and provides default routing information.

For complete information on the loopback commands, see the Cisco IOS Release 12.3 documentation set.

Perform these steps to configure a loopback interface:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface Loopback 0`
	`Router(config-int)#`
		Enters interface configuration mode.

Step 2	**ip address** *ip-address mask*
	
	Example:
	`Router(config-int)# ip address 10.108.1.1 255.255.255.0`
	`Router(config-int)#`
		Sets the IP address and subnet mask for the loopback interface.

Step 3	**exit**
	
	Example:
	`Router(config-int)# exit`
	`Router(config)#`
		Exits configuration mode for the loopback interface and returns to global configuration mode.

Configuration Example

The loopback interface in this sample configuration is used to support Network Address Translation (NAT) on the virtual-template interface. This configuration example shows the loopback interface configured on the Fast Ethernet interface with an IP address of 200.200.100.1/24, which acts as a static IP address. The loopback interface points back to virtual-template1, which has a negotiated IP address.

```
!
interface loopback 0
ip address 200.200.100.1 255.255.255.0 (static IP address)
ip nat outside
!
interface Virtual-Template1
ip unnumbered loopback0
no ip directed-broadcast
ip nat outside
```

Verifying Your Configuration

To verify that you have properly configured the loopback interface, enter the **show interface loopback** command. You should see verification output similar to the following example.

```
Router# show interface loopback 0
Loopback0 is up, line protocol is up
  Hardware is Loopback
  Internet address is 200.200.100.1/24
  MTU 1514 bytes, BW 8000000 Kbit, DLY 5000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation LOOPBACK, loopback not set
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/0, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Another way to verify the loopback interface is to ping it:

```
Router# ping 200.200.100.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.200.100.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

Configuring Command-Line Access to the Router

Perform these steps to configure parameters to control access to the router, beginning in global configuration mode:

	Command	Purpose

Step 1	**line** [**aux** | **console** | **tty** | **vty**] *line-number*
	
	Example:
	`Router(config)# line console 0`
	`Router(config)#`
		Enters line configuration mode, and specifies the type of line.
		
		This example specifies a console terminal for access.

Step 2	**password** *password*
	
	Example:
	`Router(config)# password 5dr4Hepw3`
	`Router(config)#`
		Specifies a unique password for the console terminal line.

	Command	Purpose

Step 3	**login**
	
	Example:
	`Router(config)# login`
	`Router(config)#`
		Enables password checking at terminal session login.

Step 4	**exec-timeout** *minutes* [*seconds*]
	
	Example:
	`Router(config)# exec-timeout 5 30`
	`Router(config)#`
		Sets the interval that the EXEC command interpreter waits until user input is detected. The default is 10 minutes. Optionally, add seconds to the interval value.
		
		This example shows a timeout of 5 minutes and 30 seconds. Entering a timeout of 0 0 specifies never to time out.

Step 5	**line** [**aux** | **console** | **tty** | **vty**] *line-number*
	
	Example:
	`Router(config)# line vty 0 4`
	`Router(config)#`
		Specifies a virtual terminal for remote console access.

Step 6	**password** *password*
	
	Example:
	`Router(config)# password aldf2ad1`
	`Router(config)#`
		Specifies a unique password for the virtual terminal line.

Step 7	**login**
	
	Example:
	`Router(config)# login`
	`Router(config)#`
		Enables password checking at the virtual terminal session login.

Step 8	**end**
	
	Example:
	`Router(config)# end`
	`Router#`
		Exits line configuration mode, and returns to privileged EXEC mode.

For complete information about the command line commands, see the Cisco IOS Release 12.3 documentation set.

Configuration Example

The following configuration shows the command-line access commands.

You do not need to input the commands marked "default." These commands appear automatically in the configuration file generated when you use the **show running-config** command.

```
!
line con 0
exec-timeout 10 0
password 4youreyesonly
login
transport input none (default)
stopbits 1 (default)
line vty 0 4
password secret
login
!
```

Configuring Static Routes

Static routes provide fixed routing paths through the network. They are manually configured on the router. If the network topology changes, the static route must be updated with a new route. Static routes are private routes, unless they are redistributed by a routing protocol. Configuring static routes on the Cisco 1800 series routers is optional.

Perform these steps to configure static routes, beginning in global configuration mode:

	Command	Purpose

Step 1	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]}
	
	Example:
	`Router(config)# ip route 192.168.1.0 255.255.0.0 10.10.10.2`
	`Router(config)#`
		Specifies the static route for the IP packets.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS IP Command Reference, Volume 2 of 4: Routing Protocols*.

Step 2	**end**
	
	Example:
	`Router(config)# end`
	`Router#`
		Exits router configuration mode, and enters privileged EXEC mode.

For complete information on the static routing commands, see the Cisco IOS Release 12.3 documentation set. For more general information on static routing, see Appendix B, "Concepts."

Configuration Example

In the following configuration example, the static route sends out all IP packets with a destination IP address of 192.168.1.0 and a subnet mask of 255.255.255.0 on the Fast Ethernet interface to another device with an IP address of 10.10.10.2. Specifically, the packets are sent to the configured PVC.

You do not need to enter the commands marked "(**default**)." These commands appear automatically in the configuration file generated when you use the **show running-config** command.

```
!
ip classless (default)
ip route 192.168.1.0 255.255.255.0 10.10.10.2!
```

Verifying Your Configuration

To verify that you have properly configured static routing, enter the **show ip route** command and look for static routes signified by the "S."

You should see verification output similar to the following example.

```
Router# show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 1 subnets
C       10.108.1.0 is directly connected, Loopback0
S* 0.0.0.0/0 is directly connected, FastEthernet0
```

Configuring Dynamic Routes

In dynamic routing, the network protocol adjusts the path automatically, based on network traffic or topology. Changes in dynamic routes are shared with other routers in the network.

The Cisco routers can use IP routing protocols, such as Routing Information Protocol (RIP) or Enhanced Interior Gateway Routing Protocol (EIGRP), to learn routes dynamically. You can configure either of these routing protocols on your router.

Configuring RIP

Perform these steps to configure the RIP routing protocol on the router, beginning in global configuration mode:

	Command	Task

Step 1	**router rip**
	
	Example:
	`Router> configure terminal`
	`Router(config)# router rip`
	`Router(config-router)#`
		Enters router configuration mode, and enables RIP on the router.

Step 2	**version** {**1** | **2**}
	
	Example:
	`Router(config-router)# version 2`
	`Router(config-router)#`
		Specifies use of RIP version 1 or 2.

Step 3	**network** *ip-address*
	
	Example:
	`Router(config-router)# network 192.168.1.1`
	`Router(config-router)# network 10.10.7.1`
	`Router(config-router)#`
		Specifies a list of networks on which RIP is to be applied, using the address of the network of directly connected networks.

Step 4	**no auto-summary**
	
	Example:
	`Router(config-router)# no auto-summary`
	`Router(config-router)#`
		Disables automatic summarization of subnet routes into network-level routes. This allows subprefix routing information to pass across classful network boundaries.

Step 5	**end**
	
	Example:
	`Router(config-router)# end`
	`Router#`
		Exits router configuration mode, and enters privileged EXEC mode.

For complete information on the dynamic routing commands, see the Cisco IOS Release 12.3 documentation set. For more general information on RIP, see Appendix B, “Concepts.”

Configuration Example

The following configuration example shows RIP version 2 enabled in IP network 10.0.0.0 and 192.168.1.0.

Execute the **show running-config** command from privileged EXEC mode to see this configuration.

```
!
router rip
 version 2
 network 10.0.0.0
 network 192.168.1.0
 no auto-summary
!
```

Verifying Your Configuration

To verify that you have properly configured RIP, enter the **show ip route** command and look for RIP routes signified by "R." You should see a verification output like the example shown below.

```
Router# show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 1 subnets
C       10.108.1.0 is directly connected, Loopback0
R    3.0.0.0/8 [120/1] via 2.2.2.1, 00:00:02, Ethernet0/0
```

Configuring Enhanced IGRP

Perform these steps to configure Enhanced IGRP (EIGRP), beginning in global configuration mode:

	Command	Purpose

Step 1	**router eigrp** *as-number*
	
	Example:
	`Router(config)# router eigrp 109`
	`Router(config)#`
		Enters router configuration mode, and enables EIGRP on the router. The autonomous-system number identifies the route to other EIGRP routers and is used to tag the EIGRP information.

	Command	Purpose

Step 2	**network** *ip-address*
	
	Example:
	`Router(config)# network 192.145.1.0`
	`Router(config)# network 10.10.12.115`
	`Router(config)#`
		Specifies a list of networks on which EIGRP is to be applied, using the IP address of the network of directly connected networks.

Step 3	**end**
	
	Example:
	`Router(config-router)# end`
	`Router#`
		Exits router configuration mode, and enters privileged EXEC mode.

For complete information on the IP EIGRP commands, see the Cisco IOS Release 12.3 documentation set. For more general information on EIGRP concepts, see Appendix B, "Concepts."

Configuration Example

The following configuration example shows the EIGRP routing protocol enabled in IP networks 192.145.1.0 and 10.10.12.115. The EIGRP autonomous system number is assigned as 109.

Execute the **show running-config** command from privileged EXEC mode to see this configuration.

```
!
router eigrp 109
    network 192.145.1.0
        network 10.10.12.115
!
```

Verifying Your Configuration

To verify that you have properly configured IP EIGRP, enter the **show ip route** command, and look for EIGRP routes indicated by "D." You should see verification output similar to the following example.

```
Router# show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 1 subnets
C       10.108.1.0 is directly connected, Loopback0
D    3.0.0.0/8 [90/409600] via 2.2.2.1, 00:00:02, Ethernet0/0
```

Cisco Systems

PART 2

Configuring Your Router for Ethernet and DSL Access

Sample Network Deployments

This part of the software configuration guide presents a variety of possible Ethernet- and Digital Subscriber Line (DSL)-based network configurations using Cisco 1800 series routers. Each scenario is described with a network topology, a step-by-step procedure that is used to implement the network configuration, and a configuration example that shows the results of the configuration. The Cisco 1811 and Cisco 1812 router models can be used in the Ethernet-based scenarios and the Cisco 1801, Cisco 1802, and Cisco 1803 router models can be used in the DSL-based scenarios.

The first network scenario provides a simple network configuration: point-to-point protocol (PPP) over the WAN interface with Network Address Translation (NAT). Each successive scenario builds on the previous scenario by configuring another key feature.

The scenarios do not address all of the possible network needs; instead, they provide models on which you can pattern your network. You can choose not to use features presented in the examples, or you can add or substitute features that better suit your needs.

To verify that a specific feature is compatible with your router, you can use the Software Advisor tool. You can access this tool at **www.cisco.com > Technical Support & Documentation > Tools & Resources** with your Cisco username and password.

For Ethernet-Based Network Deployments

Use the following configuration examples to assist you in configuring your router for Ethernet-based networks.

- Chapter 3, “Configuring PPP over Ethernet with NAT”
- Chapter 5, “Configuring a LAN with DHCP and VLANs”
- Chapter 6, “Configuring a VPN Using Easy VPN and an IPSec Tunnel”
- Chapter 7, “Configuring VPNs Using an IPSec Tunnel and Generic Routing Encapsulation”
- Chapter 8, “Configuring a Simple Firewall”

For DSL-Based Network Deployments

Use the following configuration examples to assist you in configuring your router for DSL-based networks.

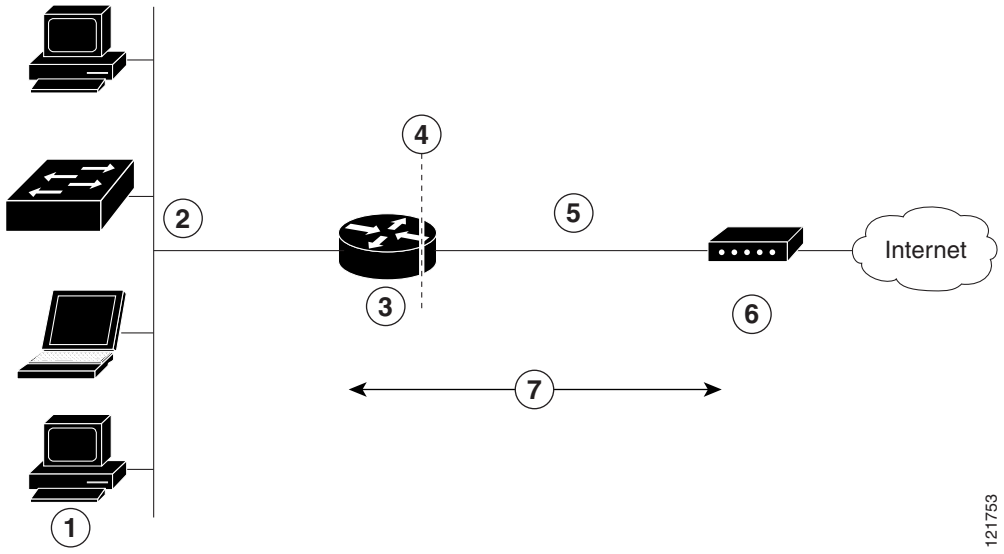
- Chapter 4, “Configuring PPP over ATM with NAT”
- Chapter 5, “Configuring a LAN with DHCP and VLANs”
- Chapter 6, “Configuring a VPN Using Easy VPN and an IPSec Tunnel”
- Chapter 7, “Configuring VPNs Using an IPSec Tunnel and Generic Routing Encapsulation”
- Chapter 8, “Configuring a Simple Firewall”

Configuring PPP over Ethernet with NAT

The Cisco 1811 and Cisco 1812 integrated services fixed-configuration routers support Point-to-Point Protocol over Ethernet (PPPoE) clients and network address translation (NAT).

Multiple PCs can be connected to the LAN behind the router. Before the traffic from these PCs is sent to the PPPoE session, it can be encrypted, filtered, and so forth. Figure 3-1 shows a typical deployment scenario with a PPPoE client and NAT configured on the Cisco router.

Figure 3-1 PPP over Ethernet with NAT



1	Multiple networked devices—desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (inside interface for NAT)
3	PPPoE client—Cisco 1811 or Cisco 1812 integrated services router
4	Point at which NAT occurs
5	Fast Ethernet WAN interface (outside interface for NAT)
6	Cable modem or other server (for example, a Cisco 6400 server) that is connected to the Internet
7	PPPoE session between the client and a PPPoE server

PPPoE

The PPPoE Client feature on the router provides PPPoE client support on Ethernet interfaces. A dialer interface must be used for cloning virtual access. Multiple PPPoE client sessions can be configured on an Ethernet interface, but each session must use a separate dialer interface and a separate dialer pool.

A PPPoE session is initiated on the client side by the Cisco 1800 series router. An established PPPoE client session can be terminated in one of two ways:

- By entering the **clear vpdn tunnel pppoe** command. The PPPoE client session terminates, and the PPPoE client immediately tries to reestablish the session. This also occurs if the session has a timeout.
- By entering the **no pppoe-client dial-pool** *number* command to clear the session. The PPPoE client does not attempt to reestablish the session.

NAT

NAT (represented as the dashed line at the edge of the Cisco router) signifies two addressing domains and the inside source address. The source list defines how the packet travels through the network.

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure the Virtual Private Dialup Network Group Number
- Configure the Fast Ethernet WAN Interfaces
- Configure the Dialer Interface
- Configure Network Address Translation

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Configure the Virtual Private Dialup Network Group Number

Configuring a virtual private dialup network (VPDN) enables multiple clients to communicate through the router by way of a single IP address.

Complete the following steps to configure a VPDN, starting from the global configuration mode. See the "Configure Global Parameters" section on page 1-6 for details about entering this mode.

	Command or Action	Purpose

Step 1	**vpdn enable**
	
	Example:
	`Router(config)# vpdn enable`
	`Router(config-vpdn)#`
		Enables VPDN on the router.

Step 2	**vpdn group** *name*
	
	Example:
	`Router(config-vpdn)# vpdn group 1`
	`Router(config-vpdn-grp)#`
		Creates and associates a VPDN group with a customer or VPDN profile.

	Command or Action	Purpose

Step 3	**request-dialin**
	
	Example:
	`Router(config-vpdn-grp)# request-dialin`
	`Router(config-vpdn-grp)#`
		Creates a request-dialin VPDN subgroup, indicating the dialing direction, and initiates the tunnel.

Step 4	**initiate to ip** *ip-address*
	
	Example:
	`Router(config-vpdn-grp)# initiate to 192.168.1.1`
	`Router(config-vpdn-grp)#`
		Specifies the address to which requests are tunneled.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Step 5	**protocol** {**l2f** | **l2tp** | **pppoe** | **any**}
	
	Example:
	`Router(config-vpdn-grp)# protocol pppoe`
	`Router(config-vpdn-grp)#`
		Specifies the type of sessions the VPDN subgroup can establish.

Step 6	**exit**
	
	Example:
	`Router(config-vpdn-grp)# exit`
	`Router(config-vpdn)#`
		Exits VPDN group configuration.

Step 7	**exit**
	
	Example:
	`Router(config-vpdn)# exit`
	`Router(config)#`
		Exits VPDN configuration, returning to global configuration mode.

Configure the Fast Ethernet WAN Interfaces

In this scenario, the PPPoE client (your Cisco router) communicates over a 10/100-Mbps Ethernet interface on both the inside and the outside.

Note The Cisco 1800 series integrated services fixed-configuration routers have a hardware limitation on the Fast Ethernet ports FE0 and FE1. In half-duplex mode, when traffic reaches or exceeds 100% capacity (equal to or greater than 5 Mbps in each direction), the interface experiences excessive collisions and resets every second. To avoid this problem, you must limit the traffic capacity to less than 100%.

Perform these steps to configure the Fast Ethernet WAN interfaces, starting in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)#interface fastethernet 0`
	`Router(config-if)#`
		Enters interface configuration mode for a Fast Ethernet WAN interface.
		
		The Cisco 1800 integrated services routers have two Fast Ethernet WAN interfaces. You can use these steps to configure one or both of them.

Step 2	**pppoe-client dial-pool-number** *number*
	
	Example:
	`Router(config-if)# pppoe-client dial-pool-number 1`
	`Router(config-if)#`
		Configures the PPPoE client and specifies the dialer interface to use for cloning.

Step 3	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the Fast Ethernet interface and the configuration changes just made to it.

Step 4	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the Fast Ethernet interface and returns to global configuration mode.

Configure the Dialer Interface

The dialer interface indicates how to handle traffic from the clients, including, for example, default routing information, the encapsulation protocol, and the dialer pool to use. The dialer interface is also used for cloning virtual access. Multiple PPPoE client sessions can be configured on a Fast Ethernet interface, but each session must use a separate dialer interface and a separate dialer pool.

Complete the following steps to configure a dialer interface for one of the Fast Ethernet LAN interfaces on the router, starting in global configuration mode.

	Command	Purpose

Step 1	**interface dialer** *dialer-rotary-group-number*
	
	Example:
	`Router(config)# interface dialer 0`
	`Router(config-if)#`
		Creates a dialer interface (numbered 0–255), and enters interface configuration mode.

Step 2	**ip address negotiated**
	
	Example:
	`Router(config-if)# ip address negotiated`
	`Router(config-if)#`
		Specifies that the IP address for the interface is obtained through PPP/IPCP (IP Control Protocol) address negotiation.

Step 3	**ip mtu** *bytes*
	
	Example:
	`Router(config-if)# ip mtu 1492`
	`Router(config-if)#`
		Sets the size of the IP maximum transmission unit (MTU). The default minimum is 128 bytes. The maximum for Ethernet is 1492 bytes.

Step 4	**encapsulation** *encapsulation-type*
	
	Example:
	`Router(config-if)# encapsulation ppp`
	`Router(config-if)#`
		Sets the encapsulation type to PPP for the data packets being transmitted and received.

Step 5	**ppp authentication** {*protocol1* [*protocol2*...]}
	
	Example:
	`Router(config-if)# ppp authentication chap`
	`Router(config-if)#`
		Sets the PPP authentication method to Challenge Handshake Authentication Protocol (CHAP).
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Security Command Reference*.

Step 6	**dialer pool** *number*
	
	Example:
	`Router(config-if)# dialer pool 1`
	`Router(config-if)#`
		Specifies the dialer pool to use to connect to a specific destination subnetwork.

	Command	Purpose

Step 7	**dialer-group** *group-number*
	
	Example:
	`Router(config-if)# dialer group 1`
	`Router(config-if)#`
		Assigns the dialer interface to a dialer group (1–10).
		
		Tip Using a dialer group controls access to your router.

Step 8	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits the dialer 0 interface configuration.

Step 9	**dialer-list** *dialer-group* **protocol** *protocol-name* {**permit** | **deny** | **list** *access-list-number* | **access-group**}
	
	Example:
	`Router(config)# dialer-list 1 protocol ip permit`
	`Router(config)#`
		Creates a dialer list and associates a dial group with it. Packets are then forwarded through the specified interface dialer group.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Step 10	**ip route** *prefix mask* {*interface-type interface-number*}
	
	Example:
	`Router(config)# ip route 10.10.25.2 0.255.255.255 dialer 0`
	`Router(config)#`
		Sets the IP route for the default gateway for the dialer 0 interface.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS IP Command Reference, Volume 2; Routing Protocols*.

Configure Network Address Translation

Network Address Translation (NAT) translates packets from addresses that match a standard access list, using global addresses allocated by the dialer interface. Packets that enter the router through the inside interface, packets sourced from the router, or both are checked against the access list for possible address translation. You can configure NAT for either static or dynamic address translations.

Perform these steps to configure the outside Fast Ethernet WAN interface with dynamic NAT, beginning in global configuration mode:

	Command	Purpose

Step 1	**ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
	
	Example:
	`Router(config)# ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 0.0.0.255`
	`Router(config)#`
		Creates pool of global IP addresses for NAT.

Step 2	**ip nat inside source** {**list** *access-list-number*} {**interface** *type number* | **pool** *name*} [**overload**]
	
	Example 1:
	`Router(config)# ip nat inside source list 1 interface dialer 0 overload`
	
	or
	
	Example 2:
	`Router(config)# ip nat inside source list acl1 pool pool1`
		Enables dynamic translation of addresses on the inside interface.
		
		The first example shows the addresses permitted by the access list *1* to be translated to one of the addresses specified in the dialer interface *0*.
		
		The second example shows the addresses permitted by access list *acl1* to be translated to one of the addresses specified in the NAT pool *pool1*.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 3	**interface** *type number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config-if)#`
		Enters configuration mode for the VLAN (on which the Fast Ethernet LAN interfaces reside) to be the inside interface for NAT.

Step 4	**ip nat** {**inside** | **outside**}
	
	Example:
	`Router(config-if)# ip nat inside`
	`Router(config-if)#`
		Identifies the specified VLAN interface as the NAT inside interface.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

	Command	Purpose

Step 5	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the configuration changes just made to the Ethernet interface.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the Fast Ethernet interface.

Step 7	**interface** *type number*
	
	Example:
	`Router(config)#interface fastethernet 0`
	`Router(config-if)#`
		Enters configuration mode for the Fast Ethernet WAN interface (FE0 or FE1) to be the outside interface for NAT.

Step 8	**ip nat** {**inside** | **outside**}
	
	Example:
	`Router(config-if)# ip nat outside`
	`Router(config-if)#`
		Identifies the specified WAN interface as the NAT outside interface.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 9	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the configuration changes just made to the Ethernet interface.

Step 10	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the Fast Ethernet interface.

Step 11	**access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*] **Example:** `Router(config)# access-list 1 permit 192.168.1.0 0.0.0.255`	Defines a standard access list indicating which addresses need translation. **Note** All other addresses are implicitly denied.

Note If you want to use NAT with a virtual-template interface, you must configure a loopback interface. See Chapter 1, "Basic Router Configuration," for information on configuring a loopback interface.

For complete information on the NAT commands, see the Cisco IOS Release 12.3 documentation set. For more general information on NAT concepts, see Appendix B, "Concepts."

Configuration Example

The following configuration example shows a portion of the configuration file for the PPPoE scenario described in this chapter.

The VLAN interface has an IP address of 192.168.1.1 with a subnet mask of 255.255.255.0. NAT is configured for inside and outside.

Note Since the VLAN interface is on LAN, we have used a private IP address.

Note Commands marked by "**(default)**" are generated automatically when you run the **show running-config** command.

```
!
vpdn enable
vpdn-group 1
request-dialin
protocol pppoe
!
interface vlan 1
ip address 192.168.1.1 255.255.255.0
no ip directed-broadcast (default)
ip nat inside
!
interface FastEthernet 0
ip address 192.1.12.2 255.255.255.0
no ip directed-broadcast (default)
ip nat outside
!
interface dialer 1
ip address negotiated
ppp authentication chap
dialer pool 1
dialer-group 1
!
dialer-list 1 protocol ip permit
ip nat inside source list 1 interface dialer 0 overload
ip classless (default)
ip route 10.10.25.2 0.255.255.255 dialer 0
!
```

Verifying Your Configuration

Use the **show ip nat statistics** command in privileged EXEC mode to verify NAT configuration. You should see verification output similar to the following example:

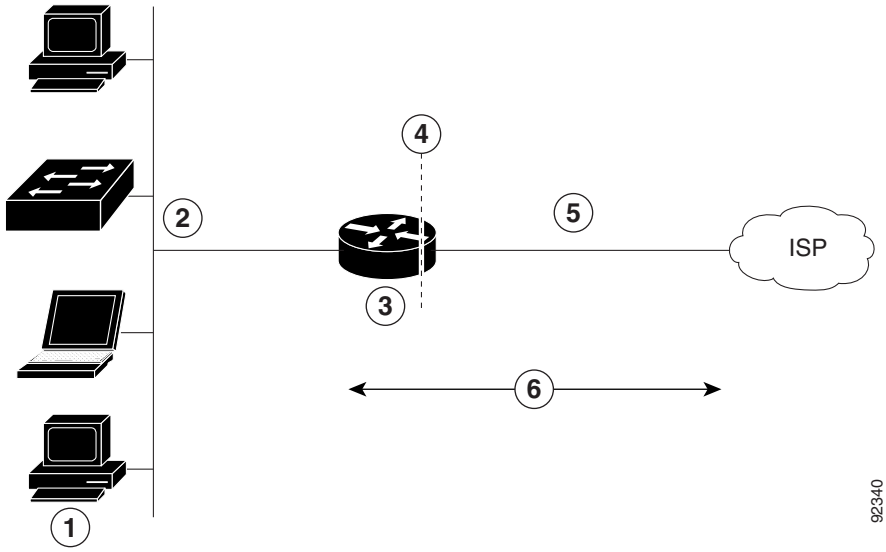
```
Router# show ip nat statistics
Total active translations: 0 (0 static, 0 dynamic; 0 extended)
Outside interfaces:
  FastEthernet4
Inside interfaces:
  Vlan1
Hits: 0  Misses: 0
CEF Translated packets: 0, CEF Punted packets: 0
Expired translations: 0
Dynamic mappings:
-- Inside Source
[Id: 1] access-list 1 interface Dialer0 refcount 0
Queued Packets: 0
```

Configuring PPP over ATM with NAT

The Cisco 1801, Cisco 1802, and Cisco 1803 access routers support Point-to-Point Protocol over Asynchronous Transfer Mode (PPPoA) clients and network address translation (NAT).

Multiple PCs can be connected to the LAN behind the router. Before traffic from the PCs is sent to the PPPoA session, it can be encrypted, filtered, and so forth. PPP over ATM provides a network solution with simplified address handling and straight user verification like a dial network. Figure 4-1 shows a typical deployment scenario with a PPPoA client and NAT configured on the Cisco router. This scenario uses a single static IP address for the ATM connection.

Figure 4-1 PPP over ATM with NAT



1	Small business with multiple networked devices—desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (inside interface for NAT, 192.168.1.1/24)
3	PPPoA Client—Cisco 1801, Cisco 1802, or Cisco 1803 router
4	Point at which NAT occurs
5	ATM WAN interface (outside interface for NAT)
6	PPPoA session between the client and a PPPoA server at the ISP

In this scenario, the small business or remote user on the Fast Ethernet LAN can connect to an Internet Service Provider (ISP) using the following protocols on the WAN connection:

- Asymmetric digital subscriber line (ADSL) over plain old telephone service (POTS) using the Cisco 1801 router
- ADSL over integrated services digital network (ISDN) using the Cisco 1802 router
- Single-pair high-speed digital subscriber line (G.SHDSL) using the Cisco 1803 router

The Fast Ethernet interface carries the data packet through the LAN and off-loads it to the PPP connection on the ATM interface. The ATM traffic is encapsulated and sent over the ADSL, ISDN, or G.SHDSL lines. The dialer interface is used to connect to the ISP.

PPPoA

The PPPoA Client feature on the router provides PPPoA client support on ATM interfaces. A dialer interface must be used for cloning virtual access. Multiple PPPoA client sessions can be configured on an ATM interface, but each session must use a separate dialer interface and a separate dialer pool.

A PPPoA session is initiated on the client side by the Cisco 1800 series router.

NAT

NAT (represented as the dashed line at the edge of the Cisco router) signifies two addressing domains and the inside source address. The source list defines how the packet travels through the network.

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure the Dialer Interface
- Configure the ATM WAN Interface
- Configure DSL Signaling Protocol
- Configure Network Address Translation

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Configure the Dialer Interface

The dialer interface indicates how to handle traffic from the clients, including, for example, default routing information, the encapsulation protocol, and the dialer pool to use. It is also used for cloning virtual access. Multiple PPPoA client sessions can be configured on an ATM interface, but each session must use a separate dialer interface and a separate dialer pool.

Perform these steps to configure a dialer interface for the ATM interface on the router, starting in global configuration mode.

	Command	Purpose

Step 1	**interface dialer** *dialer-rotary-group-number*
	
	Example:
	`Router(config)# interface dialer 0`
	`Router(config-if)#`
		Creates a dialer interface (numbered 0–255), and enters into interface configuration mode.

Step 2	**ip address negotiated**
	
	Example:
	`Router(config-if)# ip address negotiated`
	`Router(config-if)#`
		Specifies that the IP address for the dialer interface is obtained through PPP/IPCP (IP Control Protocol) address negotiation.

Step 3	**ip mtu** *bytes*
	
	Example:
	`Router(config-if)# ip mtu 4470`
	`Router(config-if)#`
		Sets the size of the IP maximum transmission unit (MTU). The default minimum is 128 bytes. The maximum for ATM is 4470 bytes.

Step 4	**encapsulation** *encapsulation-type*
	
	Example:
	`Router(config-if)# encapsulation ppp`
	`Router(config-if)#`
		Sets the encapsulation type to PPP for the data packets being transmitted and received.

Step 5	**ppp authentication** {*protocol1* [*protocol2*...]}
	
	Example:
	`Router(config-if)# ppp authentication chap`
	`Router(config-if)#`
		Sets the PPP authentication method.
		
		The example applies the Challenge Handshake Authentication Protocol (CHAP).
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Security Command Reference*.

Step 6	**dialer pool** *number*
	
	Example:
	`Router(config-if)# dialer pool 1`
	`Router(config-if)#`
		Specifies the dialer pool to use to connect to a specific destination subnetwork.

	Command	Purpose

Step 7	**dialer-group** *group-number*
	
	Example:
	`Router(config-if)# dialer-group 1`
	`Router(config-if)#`
		Assigns the dialer interface to a dialer group (1–10).
		
		Tip Using a dialer group controls access to your router.

Step 8	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits the dialer 0 interface configuration.

Step 9	**dialer-list** *dialer-group* **protocol** *protocol-name* {**permit** | **deny** | **list** *access-list-number* | **access-group**}
	
	Example:
	`Router(config)# dialer-list 1 protocol ip permit`
	`Router(config)#`
		Creates a dialer list and associates a dial group with it. Packets are then forwarded through the specified interface dialer group.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Step 10	**ip route** *prefix mask* {*interface-type interface-number*}
	
	Example:
	`Router(config)# ip route 10.10.25.0 255.255.255.0 dialer 0`
	`Router(config)#`
		Sets the IP route for the default gateway for the dialer 0 interface.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Routing Protocols*.

Repeat these steps for any additional dialer interfaces or dialer pools needed.

Configure the ATM WAN Interface

Perform these steps to configure the ATM interface, beginning in global configuration mode.

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface atm 0`
	`Router(config-if)#`
		Enters interface configuration mode for the ATM interface (labeled ADSLoPOTS or G.SHDSL on the back of your router).
		
		Note This interface was initially configured during basic router configuration. See "Configure WAN Interfaces" section on page 1-7.

Step 2	**pvc** *vpi/vci*
	
	Example:
	`Router(config-if)# pvc 8/35`
	`Router(config-if-atm-vc)#`
		Creates an ATM PVC for each end node (up to ten) with which the router communicates. Enters ATM virtual circuit configuration mode.
		
		When a PVC is defined, AAL5SNAP encapsulation is defined by default. Use the **encapsulation** command to change this, as shown in Step 3. The VPI and VCI arguments cannot be simultaneously specified as zero; if one is 0, the other cannot be 0.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Wide-Area Networking Command Reference*.

Step 3	**encapsulation** {**aal5auto** | **aal5autoppp** **virtual-template** *number* [**group** *group-name*] | **aal5ciscoppp virtual-template** *number* | **aal5mux** *protocol* | **aal5nlpid** | **aal5snap**}
	
	Example:
	`Router(config-if-atm-vc)# encapsulation aal5mux ppp dialer`
	`Router(config-if-atm-vc)#`
		Specifies the encapsulation type for the PVC and points back to the dialer interface.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Wide-Area Networking Command Reference*.

Step 4	**dialer pool-member** *number*
	
	Example:
	`Router(config-if-atm-vc)# dialer pool-member 1`
	`Router(config-if-atm-vc)#`
		Specifies the ATM interface as a member of a dialer profile dialing pool. The pool number must be in the range of 1–255.

	Command	Purpose

Step 5	**no shutdown**
	
	Example:
	`Router(config-if-atm-vc)# no shutdown`
	`Router(config-if)#`
		Enables interface and configuration changes just made to the ATM interface.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the ATM interface.

Configure DSL Signaling Protocol

DSL signaling must be configured on the ATM interface for connection to your ISP. The Cisco 1801 supports ADSL signaling over POTS, the Cisco 1802 supports ADSL signaling over ISDN, and the Cisco 1803 supports SHDSL signaling.

Based on the router you are configuring, see one of the following sections to configure the appropriate DSL signaling protocol.

- Configuring ADSL
- Configuring SHDSL

Configuring ADSL

The default configuration for ADSL signaling is shown in Table 4-1.

Table 4-1 Default ADSL Configuration

Attribute	Description	Default Value
Operating mode	Specifies the operating mode of the digital subscriber line (DSL) for an ATM interface. • ADSL over POTS—ANSI or ITU full rate, or automatic selection. • ADSL over ISDN—ITU full rate, ETSI, or automatic selection.	Auto
Loss of margin	Specifies the number of times a loss of margin may occur.	
Training log	Toggles between enabling the training log and disabling the training log.	Disabled

If you wish to change any of these settings, use one of the following commands in global configuration mode.

- **dsl operating-mode** (from the ATM interface configuration mode)
- **dsl lom** *integer*
- **dsl enable-training-log**

See the *Cisco IOS Wide-Area Networking Command Reference* for details of these commands.

Verify the Configuration

You can verify that the configuration is set the way you want using the **show dsl interface atm 0** command from privileged EXEC mode.

Configuring SHDSL

Complete the following steps to configure the DSL controller in your router to use SHDSL signaling, beginning in global configuration mode.

	Command	Purpose

Step 1	**controller dsl** *port*
	
	Example:
	`Router(config)# controller dsl 0`
	`Router(config-controller)#`
		Enters the configuration mode for the DSL controller.

Step 2	**line-term** {**co** | **cpe**}
	
	Example:
	`Router(config-controller)# line-term co`
	`Router(config-controller)#`
		Specifies if the DSL line is terminated at a central office (CO) or at customer premises equipment (CPE).

Step 3	**exit**
	
	Example:
	`Router(config-controller)# exit`
	`Router(config)#`
		Exits controller configuration mode, returning to global configuration mode.

Step 4	**mode** *protocol*
	
	Example:
	`Router(config)# mode atm`
	`Router(config-controller)#`
		Specifies the mode of the DSL controller and enters controller configuration mode.

	Command	Purpose

Step 5	**line-mode** {**4-wire enhanced** | **4-wire standard** | **2-wire**}
	
	Example:
	`Router(config-controller)# line-mode 4-wire standard`
	`Router(config-controller)#`
		Specifies whether this DSL connection is operating in 2-wire, 4-wire standard, or 4-wire enhanced mode.
		
		Note **line mode 4-wire** will default to 4-wire enhanced mode.

Step 6	**ignore-error-duration** *number*
	
	Example:
	`Router(config-controller)# ignore-error-duration 15`
	`Router(config-controller)#`
		Specifies how long, 15 to 30 seconds, to ignore errors.

Step 7	**exit**
	
	Example:
	`Router(config-controller)# exit`
	`Router(config)#`
		Exits controller configuration mode, returning to global configuration mode.

Note If you are integrating your Cisco router into a European network, please use one of the following commands:

For CO mode, use the **dsl dsl-mode shdsl symmetric annex** {**A** | **B** | **B-ANFP**} command to choose annex B or B-ANFP.

For CPE mode, use the **dsl dsl-mode shdsl symmetric annex** {**A** | **A-B** | **A-B-ANFP** | **B** | **B-ANFP**} to choose any option except option A.

The router uses annex A by default (United States).

Verify the Configuration

You can verify that the configuration is set the way you want using the **show controllers dsl** command from privileged EXEC mode.

```
Router# show controllers dsl 0
DSL 0 controller UP
SLOT 0: Globespan xDSL controller chipset
Line Mode: Four Wire Standard Mode
DSL mode: SHDSL Annex A
Frame mode: Utopia
Configured Line rate: Auto
Line Re-activated 6 times after system bootup
LOSW Defect alarm: ACTIVE
CRC per second alarm: ACTIVE
Line termination: CPE

    Current 15 min CRC: 0
    Current 15 min LOSW Defect: 0
```

```
    Current 15 min ES Defect: 0
    Current 15 min SES Defect: 0
    Current 15 min UAS Defect: 33287

    Previous 15 min CRC Defect: 0
    Previous 15 min LOSW Defect: 0
    Previous 15 min ES Defect: 0
    Previous 15 min SES Defect: 0
    Previous 15 min UAS Defect: 0

Line-0 status
Chipset Version: 0
Firmware Version: A388
Modem Status: Data, Status 1
Last Fail Mode: No Failure status:0x0
Line rate: 2312 Kbps
Framer Sync Status: In Sync
Rcv Clock Status: In the Range
Loop Attenuation: 341.1450 dB
Transmit Power: 7.5 dB
Receiver Gain: 22.5420 dB
SNR Sampling: 36.8590 dB
Dying Gasp: Present
```

Configure Network Address Translation

Network Address Translation (NAT) translates packets from addresses that match a standard access list, using global addresses allocated by the dialer interface. Packets that enter the router through the inside interface, packets sourced from the router, or both are checked against the access list for possible address translation. You can configure NAT for either static or dynamic address translations.

Perform these steps to configure the outside ATM WAN interface with dynamic NAT, beginning in global configuration mode:

	Command	Purpose

Step 1	**ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
	
	Example:
	`Router(config)# ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 0.0.0.255`
	`Router(config)#`
		Creates pool of global IP addresses for NAT.

Step 2	**ip nat inside source** {**list** *access-list-number*} {**interface** *type number* | **pool** *name*} [**overload**]
	
	Example 1:
	`Router(config)# ip nat inside source list 1 interface dialer 0 overload`
	
	or
	
	Example 2:
	`Router(config)# ip nat inside source list acl1 pool pool1`
		Enables dynamic translation of addresses on the inside interface.
		
		The first example shows the addresses permitted by the access list *1* to be translated to one of the addresses specified in the dialer interface *0*.
		
		The second example shows the addresses permitted by access list *acl1* to be translated to one of the addresses specified in the NAT pool *pool1*.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 3	**interface** *type number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config-if)#`
		Enters configuration mode for the VLAN (on which the Fast Ethernet LAN interfaces [FE2–FE9] reside) to be the inside interface for NAT.

Step 4	**ip nat** {**inside** | **outside**}
	
	Example:
	`Router(config-if)# ip nat inside`
	`Router(config-if)#`
		Applies NAT to the Fast Ethernet LAN interface as the inside interface.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 5	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the configuration changes just made to the Ethernet interface.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the Fast Ethernet interface.

	Command	Purpose

Step 7	**interface** *type number*
	
	Example:
	`Router(config)#interface fastethernet 0`
	`Router(config-if)#`
		Enters configuration mode for the ATM WAN interface (FE0 or FE1) to be the outside interface for NAT.

Step 8	**ip nat** {**inside** | **outside**}
	
	Example:
	`Router(config-if)# ip nat outside`
	`Router(config-if)#`
		Identifies the specified WAN interface as the NAT outside interface.
		
		For details about this command and additional parameters that can be set, as well as enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 9	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the configuration changes just made to the Ethernet interface.

Step 10	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits configuration mode for the ATM interface.

Step 11	**access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*] **Example:** `Router(config)# access-list 1 permit 192.168.1.0 0.0.0.255`	Defines a standard access list permitting addresses that need translation. **Note** All other addresses are implicitly denied.

Note If you want to use NAT with a virtual-template interface, you must configure a loopback interface. See Chapter 1, "Basic Router Configuration," for information on configuring the loopback interface.

For complete information on NAT commands, see the Cisco IOS Release 12.3 documentation set. For more general information on NAT concepts, see Appendix B, "Concepts."

Configuration Example

The following configuration example shows a portion of the configuration file for a client in the PPPoA scenario described in this chapter.

The VLAN interface has an IP address of 192.168.1.1 with a subnet mask of 255.255.255.0. NAT is configured for inside and outside.

Note Commands marked by "**(default)**" are generated automatically when you run the **show running-config** command.

```
!
interface Vlan1
 ip address 192.168.1.1 255.255.255.0
 ip nat inside
 ip virtual-reassembly (default)
!
interface ATM0
 no ip address
 ip nat outside
 ip virtual-reassembly
 no atm ilmi-keepalive
 pvc 8/35
  encapsulation aal5mux ppp dialer
  dialer pool-member 1
 !
 dsl operating-mode auto
!
interface Dialer0
 ip address negotiated
 ip mtu 1492
 encapsulation ppp
 dialer pool 1
 dialer-group 1
 ppp authentication chap
!
ip classless (default)
!
ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 0.0.0.255
ip nat inside source list 1 interface Dialer0 overload
!
access-list 1 permit 192.168.1.0 0.0.0.255
dialer-list 1 protocol ip permit

ip route 10.10.25.2 0.255.255.255 dialer 0
!
```

Verifying Your Configuration

Use the **show ip nat statistics** command in privileged EXEC mode to verify the PPPoA client with NAT configuration. You should see verification output similar to the following example:

```
Router# show ip nat statistics
Total active translations: 0 (0 static, 0 dynamic; 0 extended)
Outside interfaces:
  ATM0
Inside interfaces:
  Vlan1
Hits: 0  Misses: 0
CEF Translated packets: 0, CEF Punted packets: 0
Expired translations: 0
Dynamic mappings:
-- Inside Source
[Id: 1] access-list 1 interface Dialer0 refcount 0
Queued Packets: 0
```

CHAPTER 5

Configuring a LAN with DHCP and VLANs

The Cisco 1800 series integrated services fixed-configuration routers support clients on both physical LANs and virtual LANs (VLANs). The routers can use the Dynamic Host Configuration Protocol (DHCP) to enable automatic assignment of IP configurations for nodes on these networks. Other interfaces and configurations of the VLANs are described in the "Switch Port Configurations" section on page 5-7.

1	Fast Ethernet LAN (with multiple networked devices)
2	Router and DHCP server—Cisco 1800 series integrated services router—connected to the Internet
3	VLAN 1
4	VLAN 2

DHCP

DHCP, which is described in RFC 2131, uses a client/server model for address allocation. As an administrator, you can configure your Cisco 1800 integrated services fixed-configuration router to act as a DHCP server, providing IP address assignment and other TCP/IP-oriented configuration information to your workstations. DHCP frees you from having to manually assign an IP address to each client.

When you configure a DHCP server, you must configure the server properties, policies, and DHCP options.

Note Whenever you change server properties, you must reload the server with the configuration data from the Network Registrar database.

VLANs

The Cisco 1800 series integrated services routers (fixed) support eight Fast Ethernet ports on which you can configure VLANs. See the "Switch Port Configurations" section on page 5-7 for a description of the interfaces and features that can be configured on the switch ports and a link to a document containing the configuration procedures.

VLANs enable networks to be segmented and formed into logical groups of users, regardless of the user's physical location or LAN connection.

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure DHCP

- Configure VLANs

Note The procedures in this chapter assume you have already configured basic router features as well as PPPoE or PPPoA with NAT. If you have not performed these configurations tasks, see Chapter 1, "Basic Router Configuration," Chapter 3, "Configuring PPP over Ethernet with NAT," and Chapter 4, "Configuring PPP over ATM with NAT" as appropriate for your router. See the *Cisco IOS IP Configuration Guide* to assign an IP address to the ports.

Configure DHCP

Perform these steps to configure your router for DHCP operation, beginning in global configuration mode:

	Command	Purpose

Step 1	**ip domain name** *name*
	
	Example:
	`Router(config)# ip domain name smallbiz.com`
	`Router(config)#`
		Identifies the default domain that the router uses to complete unqualified hostnames (names without a dotted-decimal domain name).

Step 2	**ip name-server** *server-address1 [server-address2...server-address6]*
	
	Example:
	`Router(config)# ip name-server 192.168.11.12`
	`Router(config)#`
		Specifies the address of one or more Domain Name System (DNS) servers to use for name and address resolution.

Step 3	**ip dhcp excluded-address** *low-address [high-address]* **Example:** `Router(config)# ip dhcp excluded-address 192.168.9.0`	Specifies IP addresses that the DHCP server should not assign to DHCP clients. In this example, we are excluding the router address.

Step 4	**ip dhcp pool** *name*
	
	Example:
	`Router(config)# ip dhcp pool dpool1`
	`Router(config-dhcp)#`
		Creates a DHCP address pool on the router and enters DHCP pool configuration mode. The *name* argument can be a string or an integer.

Step 5	**network** *network-number* [*mask* | *prefix-length*]
	
	Example:
	`Router(config-dhcp)# network 10.10.0.0 255.255.255.0`
	`Router(config-dhcp)#`
		Defines subnet number (IP) address for the DHCP address pool, optionally including the mask.

	Command	Purpose

Step 6	**import all**
	
	Example:
	`Router(config-dhcp)# import all`
	`Router(config-dhcp)#`
		Imports DHCP option parameters into the DHCP portion of the router database.

Step 7	**default-router** *address* [*address2...address8*]
	
	Example:
	`Router(config-dhcp)# default-router 10.1.1.1`
	`Router(config-dhcp)#`
		Specifies up to 8 default routers for a DHCP client.

Step 8	**dns-server** *address* [*address2...address8*]
	
	Example:
	`Router(config-dhcp)# dns-server 192.168.35.2`
	`Router(config-dhcp)#`
		Specifies up to 8 DNS servers available to a DHCP client.

Step 9	**domain-name** *domain*
	
	Example:
	`Router(config-dhcp)# domain-name cisco.com`
	`Router(config-dhcp)#`
		Specifies the domain name for a DHCP client.

Step 10	**exit**
	
	Example:
	`Router(config-dhcp)# exit`
	`Router(config)#`
		Exits DHCP configuration mode, and enters global configuration mode.

Configuration Example

The following configuration example shows a portion of the configuration file for the DCHP configuration described in this chapter.

```
ip dhcp excluded-address 192.168.9.0
!
ip dhcp pool dpool1
   import all
   network 10.10.0.0 255.255.255.0
   default-router 10.10.10.10
   dns-server 192.168.35.2
   domain-name cisco.com
!
ip domain name smallbiz.com
ip name-server 192.168.11.12
```

Verify Your DHCP Configuration

Use the following commands to view your DHCP configuration.

- **show ip dhcp import**—Displays the optional parameters imported into the DHCP server database.
- **show ip dhcp pool**—Displays information about the DHCP address pools.
- **show ip dhcp server statistics**—Displays the DHCP server statistics, such as the number of address pools, bindings, and so forth.

```
Router# show ip dhcp import

Address Pool Name: dpool1

Router# show ip dhcp pool

Pool dpool1 :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 0 / 0
 Total addresses                : 254
 Leased addresses               : 0
 Pending event                  : none
 1 subnet is currently in the pool :
 Current index        IP address range                    Leased addresses
 10.10.0.1            10.10.0.1        - 10.10.0.254       0

Router# show ip dhcp server statistics
Memory usage         15419
Address pools        1
Database agents      0
Automatic bindings   0
Manual bindings      0
Expired bindings     0
Malformed messages   0
Secure arp entries   0

Message              Received
BOOTREQUEST          0
DHCPDISCOVER         0
DHCPREQUEST          0
DHCPDECLINE          0
DHCPRELEASE          0
DHCPINFORM           0

Message              Sent
BOOTREPLY            0
DHCPOFFER            0
DHCPACK              0
DHCPNAK              0
Router#
```

Configure VLANs

Perform these steps to configure VLANs on your router, beginning in global configuration mode:

	Command	Purpose

Step 1	**vlan ?**
	Example:
	`Router# config t`
	`Router(config)#vlan ?`
	
	`WORD  ISL VLAN IDs 1-4094`
	`accounting  VLAN accounting configuration`
	`ifdescr  VLAN subinterface ifDescr`
	
	`Router(config)#vlan`
		Enters VLAN configuration mode.

Step 2	*ISL VLAN ID*
	Example:
	`Router(config)#vlan 2`
	`Router(config-vlan)#`
		Adds VLANs, with identifiers ranging from 1- 4094.
		For details about this command and additional parameters that can be set, see the *Cisco IOS Switching Services Command Reference*.

Step 3	**exit**
	Example:
	`Router(config-vlan)#exit`
	`Router(config)#`
		Updates the VLAN database, propagates it throughout the administrative domain, and returns to global configuration mode.

Verify Your VLAN Configuration

Use the following commands to view your VLAN configuration.

- **show**—Entered from VLAN database mode. Displays summary configuration information for all configured VLANs.
- **show vlan-switch**—Entered from privileged EXEC mode. Displays detailed configuration information for all configured VLANs.

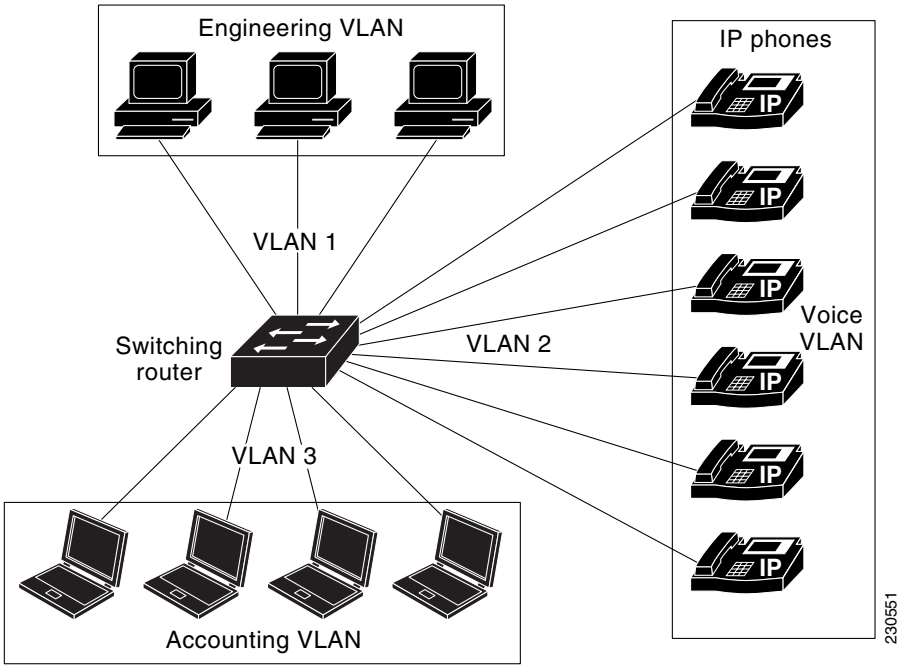
```
Router# vlan database
Router(vlan)# show
  VLAN ISL Id: 1
    Name: default
    Media Type: Ethernet
    VLAN 802.10 Id: 100001
    State: Operational
    MTU: 1500
    Translational Bridged VLAN: 1002
    Translational Bridged VLAN: 1003

  VLAN ISL Id: 1002
    Name: fddi-default
    Media Type: FDDI
    VLAN 802.10 Id: 101002
    State: Operational
    MTU: 1500
    Bridge Type: SRB
```

```
    Translational Bridged VLAN: 1
    Translational Bridged VLAN: 1003

  VLAN ISL Id: 1003
    Name: token-ring-default
    Media Type: Token Ring
    VLAN 802.10 Id: 101003
    State: Operational
    MTU: 1500
    Bridge Type: SRB
    Ring Number: 0
    Bridge Number: 1
    Parent VLAN: 1005
    Maximum ARE Hop Count: 7
    Maximum STE Hop Count: 7
    Backup CRF Mode: Disabled
    Translational Bridged VLAN: 1
    Translational Bridged VLAN: 1002

  VLAN ISL Id: 1004
    Name: fddinet-default
    Media Type: FDDI Net
    VLAN 802.10 Id: 101004
    State: Operational
    MTU: 1500
    Bridge Type: SRB
    Bridge Number: 1
    STP Type: IBM

  VLAN ISL Id: 1005
    Name: trnet-default
    Media Type: Token Ring Net
    VLAN 802.10 Id: 101005
    State: Operational
    MTU: 1500
    Bridge Type: SRB
    Bridge Number: 1
    STP Type: IBM

Router# show vlan-switch

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0, Fa1, Fa2, Fa3
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        1002   1003
1002 fddi  101002     1500  -      -      -        -    -        1      1003
1003 tr    101003     1500  1005   0      -        -    srb      1      1002
1004 fdnet 101004     1500  -      -      1        ibm  -        0      0
1005 trnet 101005     1500  -      -      1        ibm  -        0      0
Router#
```

Switch Port Configurations

The 8 high speed Ethernet ports on the Cisco 1800 (fixed) integrated router supports 8 VLANs per port. To configure and verify VLANs on the switch ports see the the "Configure VLANs" section on page 5-5 and the "Verify Your VLAN Configuration" section on page 5-5.

Figure 5-1 VLAN Configuration on the Cisco 1800 (Fixed) Router Showing Three VLAN Segments



Other procedures for configuring the switch ports, including configuration examples and information on the features and interfaces are in the *Cisco HWIC-4ESW and HWIC-9ESW EtherSwitch Interface Cards* document on Cisco.com. See this document to configure the switch ports. The configuration procedures described in this document are listed below.

- Configuring VLANs (required)
- Configuring VLAN Trunking Protocol (optional)
- Configuring 802.1x Authentication (required)
- Configuring Spanning Tree on a VLAN (required)
- Configuring Layer 2 Interfaces (required)
- Configuring MAC Table Manipulation (required)
- Configuring the Switched Port Analyzer (required)
- Configuring Power Management on the Interfaces (optional)
- IP Multicast Layer 3 Switching (required)
- Configuring Per-Port Storm Control (optional)
- Configuring Fallback Bridging (optional)
- Configuring Separate Voice and Data Submits (optional)
- Configuring IGMP Snooping (optional)

This section briefly describes the features and interfaces that can be configured on the VLANs assigned to the switch ports and any differences between the configurations for the HWIC-4ESW and HWIC-9ESW and the configuration of the switch ports.

VLAN Trunking Protocol (VTP)

VLAN Trunking Protocol(VTP) supports three types of VTP modes – server, client and transparent modes. In VTP server mode, you create, modify and delete VLANs and specify other configuration parameters such as the VTP version for the entire VTP domain. VTP clients behave the same way as VTP servers, but you cannot create, change or delete VLANs on a VTP client. A VTP transparent switch does not advertise its' VLAN configuration, and does not synchronize its VLAN configuration based on received advertisements.

802.1x Authentication

The switch port determines whether a client is granted access to the network. In the default setting, the port is in the unauthorized state. While in this state, the port disallows all ingress and egress traffic except for 802.1x packets. When a client has successfully authenticated, the port changes to the authorized state, allowing all traffic for the client to flow normally.

If a client that does not support 802.1x is connected to an unauthorized 802.1x port, the switch requests the client's identity. In this situation, the client does not respond to the request, the port remains in the unauthorized state, and the client is not granted access to the network.

The 802.1x protocol supports authentication and full authentication, authorization, and accounting [AAA] and RADIUS modes with port VLAN ID (PVID) and voice VLAN ID (VVID); and with VLAN assignment with guest VLAN single and multi-host support on the Cisco 1800 (fixed) Configuration Series.

Note These security features are not supported on the switch ports: Security Access Control Lists, IP Access Control Lists (IP- ACLs) for Layer 2 ports, and VLAN ACLs Virtual ACLs.

Layer 2 Interfaces

The integrated switch ports support Layer 2 switching across Ethernet ports based on Cisco IOS Catalyst Software. They support simultaneous, parallel connections between Layer 2 Ethernet segments. Switched connections between Ethernet segments last only for the duration of the packet. Different connections can be made for different segments for the next packet. You can configure a range of Layer 2 interfaces, define a range macro, set the interface speed, set the duplex mode, and add a description for the interface.

MAC Table Manipulation

The MAC table is configured to provide port security. The switch ports use the MAC address tables to forward traffic between the ports. All MAC addresses in the address table are associated with one or more ports. The MAC tables include the following types of addresses:

- Dynamic address–the source MAC address that the switch learns and then drops when not in use.
- Secure address–manually entered unicast address that is usually associated with a secured port. Secure addresses do not age.
- Static address–manually entered unicast or multicast address that does not age and that is not lost when the switch resets.

The Cisco 1800 (Fixed) Configuration Series supports 100 secure and static MAC addresses. General MAC addresses are supported for 50 users.

Maximum Switched Virtual Interfaces (SVIs)

A switch virtual interface (SVI) represents a VLAN of switch ports as one interface to the routing or bridging function in the router. Only one SVI can be associated with a VLAN; it is necessary to configure an SVI for a VLAN only when you wish to route between VLANs, when you wish to configure fallback-bridge nonroutable protocols between VLANs, or when you wish to provide IP host connectivity. Eight SVI interfaces are supported on each port of the fixed router

Switched Port Analyzer (SPAN)

You can configure SPAN sessions using parameters that specify the type of network traffic to monitor. SPAN sessions allow you to monitor traffic in one or more interfaces and allow you to send ingress traffic, egress traffic or both to one destination interface.

You can enable spanning tree on a per-VLAN basis and configure various spanning tree features. All frames have 802.1q tags.

IP Multicast Switching

Multicast switching is Layer 3 switching. To configure Multicast switching, the maximum number of configured VLANs must be less than or equal to 242. The maximum number of multicast groups is equal to to the maximum number of VLANs.

You can configure your router to enable multi-cast switching globally, enable IP Protocol Independent Multicast (PIM) on a Layer 3 interface, and verify the Multicast Layer 3 switching information.

Note Per-Port enabling and disabling of unknown multicast and unicast packets is not supported on the Cisco 1800 (Fixed) configuration router.

Per-Port Storm Control

You can use these per-port storm control techniques to block the forwarding of unnecessary, flooded traffic.

Fallback Bridging

With Fallback Bridging, the switch bridges together two or more VLANs or routed ports, essentially connecting multiple VLANs within one bridge domain.

To configure Fallback Bridging for a set of SVIs, the SVIs must be assigned to bridge groups. All bridges in the same group belong to the same bridge domain. Each SVI can be assigned to only one bridge group.

Separate Voice and Data Subnets

For ease of network administration and increased scalability, network managers can configure the switch ports to support Cisco IP phones such that the voice and data traffic reside on separate subnets.

IGMP Snooping

By default, IGMP Snooping is globally enabled on the switch ports. When globally enabled or disabled, it is also enabled or disabled on all VLAN interfaces. It can be enabled and disabled on a per-VLAN basis.

Note All of the procedures for configuring the switch ports, including configuration examples and information on the features and interfaces are in the *Cisco HWIC-4ESW and HWIC-9ESW EtherSwitch Interface Cards* document on Cisco.com. See this document to configure the switch ports.

Configuring a VPN Using Easy VPN and an IPSec Tunnel

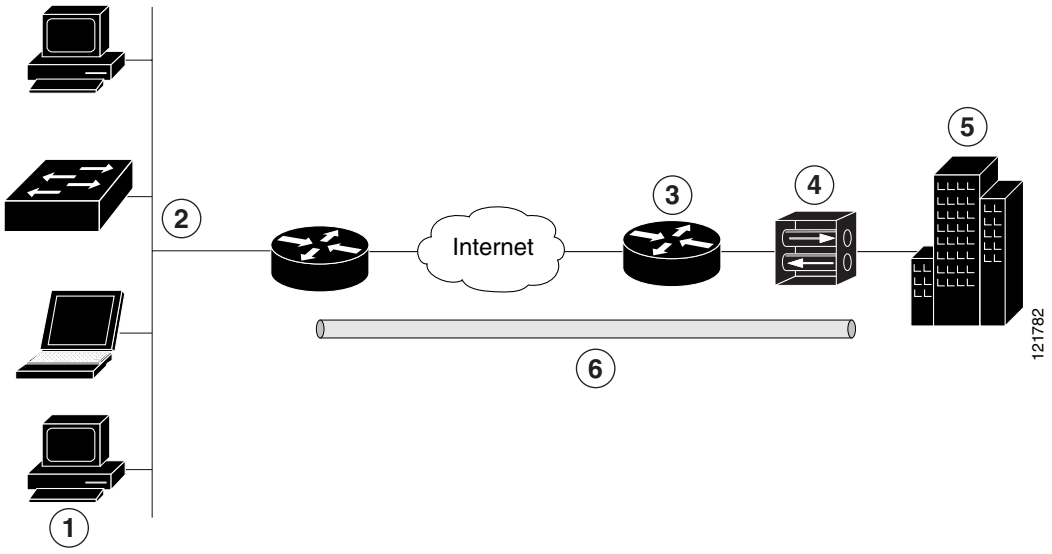
The Cisco 1800 series integrated services fixed-configuration routers support the creation of Virtual Private Networks (VPNs).

Cisco routers and other broadband devices provide high-performance connections to the Internet, but many applications also require the security of VPN connections which perform a high level of authentication and which encrypt the data between two particular endpoints.

Two types of VPNs are supported—site-to-site and remote access. Site-to-site VPNs are used to connect branch offices to corporate offices, for example. Remote access VPNs are used by remote clients to log in to a corporate network.

The example in this chapter illustrates the configuration of a remote access VPN that uses the Cisco Easy VPN and an IPSec tunnel to configure and secure the connection between the remote client and the corporate network. Figure 6-1 shows a typical deployment scenario.

Figure 6-1 Remote Access VPN Using IPSec Tunnel



1	Remote, networked users
2	VPN client—Cisco 1800 series integrated services router
3	Router—Providing the corporate office network access
4	VPN server—Easy VPN server; for example, a Cisco VPN 3000 concentrator with outside interface address 192.168.101.1
5	Corporate office with a network address of 10.1.1.1
6	IPSec tunnel

Cisco Easy VPN

The Cisco Easy VPN client feature eliminates much of the tedious configuration work by implementing the Cisco Unity Client protocol. This protocol allows most VPN parameters, such as internal IP addresses, internal subnet masks, DHCP server addresses, WINS server addresses, and split-tunneling flags, to be defined at a VPN server, such as a Cisco VPN 3000 series concentrator that is acting as an IPSec server.

An Easy VPN server–enabled device can terminate VPN tunnels initiated by mobile and remote workers who are running Cisco Easy VPN Remote software on PCs. Easy VPN server–enabled devices allow remote routers to act as Easy VPN Remote nodes.

The Cisco Easy VPN client feature can be configured in one of two modes—client mode or network extension mode. Client mode is the default configuration and allows only devices at the client site to access resources at the central site. Resources at the client site are unavailable to the central site. Network extension mode allows users at the central site (where the VPN 3000 series concentrator is located) to access network resources on the client site.

After the IPSec server has been configured, a VPN connection can be created with minimal configuration on an IPSec client, such as a supported Cisco 1800 integrated services router. When the IPSec client initiates the VPN tunnel connection, the IPSec server pushes the IPSec policies to the IPSec client and creates the corresponding VPN tunnel connection.

Note The Cisco Easy VPN client feature supports configuration of only one destination peer. If your application requires creation of multiple VPN tunnels, you must manually configure the IPSec VPN and Network Address Translation/Peer Address Translation (NAT/PAT) parameters on both the client and the server.

Configuration Tasks

Perform the following tasks to configure your router for this network scenario:

- Configure the IKE Policy
- Configure Group Policy Information
- Apply Mode Configuration to the Crypto Map
- Enable Policy Lookup
- Configure IPSec Transforms and Protocols
- Configure the IPSec Crypto Method and Parameters
- Apply the Crypto Map to the Physical Interface
- Create an Easy VPN Remote Configuration

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Note The procedures in this chapter assume that you have already configured basic router features as well as PPPoE or PPPoA with NAT, DCHP and VLANs. If you have not performed these configurations tasks, see Chapter 1, "Basic Router Configuration," Chapter 3, "Configuring PPP over Ethernet with NAT," Chapter 4, "Configuring PPP over ATM with NAT," and Chapter 5, "Configuring a LAN with DHCP and VLANs" as appropriate for your router.

Configure the IKE Policy

Perform these steps to configure the Internet Key Exchange (IKE) policy, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto isakmp policy** *priority*
	
	Example:
	`Router(config)# crypto isakmp policy 1`
	`Router(config-isakmp)#`
		Creates an IKE policy that is used during IKE negotiation. The priority is a number from 1 to 10000, with 1 being the highest.
		
		Also enters the Internet Security Association Key and Management Protocol (ISAKMP) policy configuration mode.

Step 2	**encryption** {**des** | **3des** | **aes** | **aes 192** | **aes 256**}
	
	Example:
	`Router(config-isakmp)# encryption 3des`
	`Router(config-isakmp)#`
		Specifies the encryption algorithm used in the IKE policy.
		
		The example specifies 168-bit data encryption standard (DES).

Step 3	**hash** {**md5** | **sha**}
	
	Example:
	`Router(config-isakmp)# hash md5`
	`Router(config-isakmp)#`
		Specifies the hash algorithm used in the IKE policy.
		
		The example specifies the Message Digest 5 (MD5) algorithm. The default is Secure Hash standard (SHA-1).

Step 4	**authentication** {**rsa-sig** | **rsa-encr** | **pre-share**}
	
	Example:
	`Router(config-isakmp)# authentication pre-share`
	`Router(config-isakmp)#`
		Specifies the authentication method used in the IKE policy.
		
		The example specifies a pre-shared key.

Step 5	**group** {**1** | **2** | **5**}
	
	Example:
	`Router(config-isakmp)# group 2`
	`Router(config-isakmp)#`
		Specifies the Diffie-Hellman group to be used in an IKE policy.

	Command or Action	Purpose

Step 6	**lifetime** *seconds*
	
	Example:
	`Router(config-isakmp)# lifetime 480`
	`Router(config-isakmp)#`
		Specifies the lifetime, 60–86400 seconds, for an IKE security association (SA).

Step 7	**exit**
	
	Example:
	`Router(config-isakmp)# exit`
	`Router(config)#`
		Exits IKE policy configuration mode, and enters global configuration mode.

Configure Group Policy Information

Perform these steps to configure the group policy, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto isakmp client configuration group** {**group-name** | **default**}
	
	Example:
	`Router(config)# crypto isakmp client configuration group rtr-remote`
	`Router(config-isakmp-group)#`
		Creates an IKE policy group containing attributes to be downloaded to the remote client.
		Also enters the Internet Security Association Key and Management Protocol (ISAKMP) group policy configuration mode.

Step 2	**key** *name*
	
	Example:
	`Router(config-isakmp-group)# key secret-password`
	`Router(config-isakmp-group)#`
		Specifies the IKE pre-shared key for the group policy.

Step 3	**dns** *primary-server*
	
	Example:
	`Router(config-isakmp-group)# dns 10.50.10.1`
	`Router(config-isakmp-group)#`
		Specifies the primary Domain Name System (DNS) server for the group.
		Note You may also want to specify Windows Internet Naming Service (WINS) servers for the group by using the **wins** command.

Step 4	**domain** *name*
	
	Example:
	`Router(config-isakmp-group)# domain company.com`
	`Router(config-isakmp-group)#`
		Specifies group domain membership.

	Command or Action	Purpose

Step 5	**exit**
	
	Example:
	`Router(config-isakmp-group)# exit`
	`Router(config)#`
		Exits IKE group policy configuration mode, and enters global configuration mode.

Step 6	**ip local pool** {**default** | *poolname*} [*low-ip-address* [*high-ip-address*]]
	
	Example:
	`Router(config)# ip local pool dynpool 30.30.30.20 30.30.30.30`
	`Router(config)#`
		Specifies a local address pool for the group.
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Apply Mode Configuration to the Crypto Map

Perform these steps to apply mode configuration to the crypto map, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto map** *map-name* **isakmp authorization list** *list-name*
	
	Example:
	`Router(config)# crypto map dynmap isakmp authorization list rtr-remote`
	`Router(config)#`
		Applies mode configuration to the crypto map and enables key lookup (IKE queries) for the group policy from an authentication, authorization, and accounting (AAA) server.

Step 2	**crypto map** *tag* **client configuration address** [**initiate** | **respond**]
	
	Example:
	`Router(config)# crypto map dynmap client configuration address respond`
	`Router(config)#`
		Configures the router to reply to mode configuration requests from remote clients.

Enable Policy Lookup

Perform these steps to enable policy lookup through AAA, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**aaa new-model**
	
	Example:
	`Router(config)# aaa new-model`
	`Router(config)#`
		Enables the AAA access control model.

Step 2	**aaa authentication login** {**default** | *list-name*} *method1* [*method2...*]
	
	Example:
	`Router(config)# aaa authentication login rtr-remote local`
	`Router(config)#`
		Specifies AAA authentication of selected users at login, and specifies the method used.
		
		This example uses a local authentication database. You could also use a RADIUS server for this. For details, see the *Cisco IOS Security Configuration Guide* and *Cisco IOS Security Command Reference*.

Step 3	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2...*]]
	
	Example:
	`Router(config)# aaa authorization network rtr-remote local`
	`Router(config)#`
		Specifies AAA authorization of all network-related service requests, including PPP, and specifies the method of authorization.
		
		This example uses a local authorization database. You could also use a RADIUS server for this. For details, see the *Cisco IOS Security Configuration Guide* and *Cisco IOS Security Command Reference*.

Step 4	**username** *name* {**nopassword** | **password** *password* | **password** *encryption-type encrypted-password*}
	
	Example:
	`Router(config)# username Cisco password 0 Cisco`
	`Router(config)#`
		Establishes a username-based authentication system.
		
		This example implements a username of *Cisco* with an encrypted password of *Cisco*.

Configure IPSec Transforms and Protocols

A transform set represents a certain combination of security protocols and algorithms. During IKE negotiation, the peers agree to use a particular transform set for protecting data flow.

During IKE negotiations, the peers search in multiple transform sets for a transform that is the same at both peers. When such a transform set is found, it is selected and applied to the protected traffic as a part of both peers' configurations.

Perform these steps to specify the IPSec transform set and protocols, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*] [*transform4*]
	
	Example:
	`Router(config)# crypto ipsec transform-set vpn1 esp-3des esp-sha-hmac`
	`Router(config)#`
		Defines a transform set—an acceptable combination of IPSec security protocols and algorithms.
		
		See the *Cisco IOS Security Command Reference* for detail about the valid transforms and combinations.

Step 2	**crypto ipsec security-association lifetime** {**seconds** *seconds* | **kilobytes** *kilobytes*}
	
	Example:
	`Router(config)# crypto ipsec security-association lifetime seconds 86400`
	`Router(config)#`
		Specifies global lifetime values used when IPSec security associations are negotiated.
		
		See the *Cisco IOS Security Command Reference* for details.

Note With manually established security associations, there is no negotiation with the peer, and both sides must specify the same transform set.

Configure the IPSec Crypto Method and Parameters

A dynamic crypto map policy processes negotiation requests for new security associations from remote IPSec peers, even if the router does not know all the crypto map parameters (for example, IP address).

Perform these steps to configure the IPSec crypto method, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto dynamic-map** *dynamic-map-name dynamic-seq-num*
	
	Example:
	`Router(config)# crypto dynamic-map dynmap 1`
	`Router(config-crypto-map)#`
		Creates a dynamic crypto map entry and enters crypto map configuration mode.
		
		See the *Cisco IOS Security Command Reference* for more detail about this command.

Step 2	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
	
	Example:
	`Router(config-crypto-map)# set transform-set vpn1`
	`Router(config-crypto-map)#`
		Specifies which transform sets can be used with the crypto map entry.

	Command or Action	Purpose

Step 3	**reverse-route**
	
	Example:
	`Router(config-crypto-map)# reverse-route`
	`Router(config-crypto-map)#`
		Creates source proxy information for the crypto map entry.
		
		See the *Cisco IOS Security Command Reference* for details.

Step 4	**exit**
	
	Example:
	`Router(config-crypto-map)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Step 5	**crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*]
	
	Example:
	`Router(config)# crypto map static-map 1 ipsec-isakmp dynamic dynmap`
	`Router(config)#`
		Creates a crypto map profile.

Apply the Crypto Map to the Physical Interface

The crypto maps must be applied to each interface through which IP Security (IPSec) traffic flows. Applying the crypto map to the physical interface instructs the router to evaluate all the traffic against the security associations database. With the default configurations, the router provides secure connectivity by encrypting the traffic sent between remote sites. However, the public interface still allows the rest of the traffic to pass and provides connectivity to the Internet.

Perform these steps to apply a crypto map to an interface, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 0`
	`Router(config-if)#`
		Enters the interface configuration mode for the interface to which you want the crypto map applied.

	Command or Action	Purpose

Step 2	**crypto map** *map-name*
	
	Example:
	`Router(config-if)# crypto map static-map`
	`Router(config-if)#`
		Applies the crypto map to the interface.
		
		See the *Cisco IOS Security Command Reference* for more detail about this command.

Step 3	**exit**
	
	Example:
	`Router(config-crypto-map)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Create an Easy VPN Remote Configuration

The router acting as the IPSec remote router must create an Easy VPN remote configuration and assign it to the outgoing interface.

Perform these steps to create the remote configuration, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto ipsec client ezvpn** *name*
	
	Example:
	`Router(config)# crypto ipsec client ezvpn ezvpnclient`
	`Router(config-crypto-ezvpn)#`
		Creates a Cisco Easy VPN remote configuration, and enters Cisco Easy VPN remote configuration mode.

Step 2	**group** *group-name* **key** *group-key*
	
	Example:
	`Router(config-crypto-ezvpn)# group ezvpnclient key secret-password`
	`Router(config-crypto-ezvpn)#`
		Specifies the IPSec group and IPSec key value for the VPN connection.

Step 3	**peer** {*ipaddress* | *hostname*}
	
	Example:
	`Router(config-crypto-ezvpn)# peer 192.168.100.1`
	`Router(config-crypto-ezvpn)#`
		Specifies the peer IP address or hostname for the VPN connection.
		
		Note A hostname can be specified only when the router has a DNS server available for hostname resolution.

Step 4	**mode** {**client** | **network-extension** | **network extension plus**}
	
	Example:
	`Router(config-crypto-ezvpn)# mode client`
	`Router(config-crypto-ezvpn)#`
		Specifies the VPN mode of operation.

	Command or Action	Purpose

Step 5	**exit**
	
	Example:
	`Router(config-crypto-ezvpn)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Step 6	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 0`
	`Router(config-if)#`
		Enters interface configuration mode.
		
		Note For routers with an ATM WAN interface, this command would be **interface atm 0**.

Step 7	**crypto ipsec client ezvpn** *name* [**outside** | **inside**]
	
	Example:
	`Router(config-if)# crypto ipsec client ezvpn ezvpnclient outside`
	`Router(config-if)#`
		Assigns the Cisco Easy VPN remote configuration to the WAN interface, causing the router to automatically create the NAT or PAT and access list configuration needed for the VPN connection.

Step 8	**exit**
	
	Example:
	`Router(config-crypto-ezvpn)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Verifying Your Easy VPN Configuration

```
Router# show crypto ipsec client ezvpn
Tunnel name :ezvpnclient
Inside interface list:vlan 1
Outside interface:fastethernet 0
Current State:IPSEC_ACTIVE
Last Event:SOCKET_UP
Address:8.0.0.5
Mask:255.255.255.255
Default Domain:cisco.com
```

Configuration Example

The following configuration example shows a portion of the configuration file for the VPN and IPSec tunnel described in this chapter.

```
!
aaa new-model
!
aaa authentication login rtr-remote local
aaa authorization network rtr-remote local
aaa session-id common
!
username Cisco password 0 Cisco
```

```
!
crypto isakmp policy 1
    encryption 3des
    authentication pre-share
    group 2
    lifetime 480
!
crypto isakmp client configuration group rtr-remote
    key secret-password
    dns 10.50.10.1 10.60.10.1
    domain company.com
    pool dynpool
!
crypto ipsec transform-set vpn1 esp-3des esp-sha-hmac
!
crypto ipsec security-association lifetime seconds 86400
!
crypto dynamic-map dynmap 1
    set transform-set vpn1
    reverse-route
!
crypto map static-map 1 ipsec-isakmp dynamic dynmap
crypto map dynmap isakmp authorization list rtr-remote
crypto map dynmap client configuration address respond

crypto ipsec client ezvpn ezvpnclient
    connect auto
    group 2 key secret-password
    mode client
    peer 192.168.100.1
!

interface fastethernet 0
    crypto ipsec client ezvpn ezvpnclient outside
    crypto map static-map
!
interface vlan 1
    crypto ipsec client ezvpn ezvpnclient inside
!
```

Configuring VPNs Using an IPSec Tunnel and Generic Routing Encapsulation

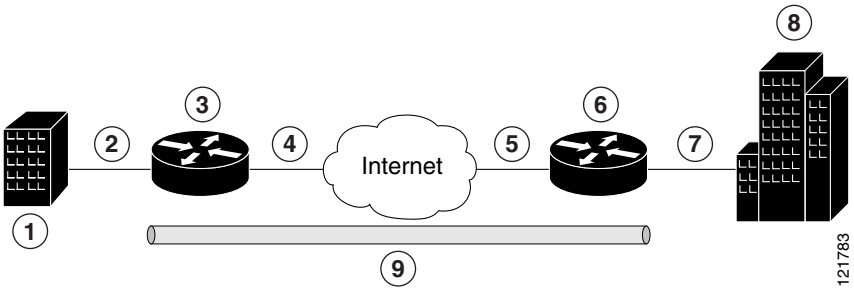
The Cisco 1800 series integrated services fixed-configuration routers support the creation of virtual private networks (VPNs).

Cisco routers and other broadband devices provide high-performance connections to the Internet, but many applications also require the security of VPN connections which perform a high level of authentication and which encrypt the data between two particular endpoints.

Two types of VPNs are supported—site-to-site and remote access. Site-to-site VPNs are used to connect branch offices to corporate offices, for example. Remote access VPNs are used by remote clients to log in to a corporate network.

The example in this chapter illustrates the configuration of a site-to-site VPN that uses IPSec and the generic routing encapsulation (GRE) protocol to secure the connection between the branch office and the corporate network. Figure 7-1 shows a typical deployment scenario.

Figure 7-1 Site-to-Site VPN Using an IPSec Tunnel and GRE



1	Branch office containing multiple LANs and VLANs
2	Fast Ethernet LAN interface—With address 192.165.0.0/16 (also the inside interface for NAT)
3	VPN client—Cisco 1800 series integrated services router
4	Fast Ethernet or ATM interface—With address 200.1.1.1 (also the outside interface for NAT)
5	LAN interface—Connects to the Internet; with outside interface address of 210.110.101.1
6	VPN client—Another router, which controls access to the corporate network

7	LAN interface—Connects to the corporate network, with inside interface address of 10.1.1.1
8	Corporate office network
9	IPSec tunnel with GRE

GRE Tunnels

GRE tunnels are typically used to establish a VPN between the Cisco router and a remote device that controls access to a private network, such as a corporate network. Traffic forwarded through the GRE tunnel is encapsulated and routed out onto the physical interface of the router. When a GRE interface is used, the Cisco router and the router that controls access to the corporate network can support dynamic IP routing protocols to exchange routing updates over the tunnel, and to enable IP multicast traffic. Supported IP routing protocols include Enhanced Interior Gateway Routing Protocol (EIGRP), Routing Information Protocol (RIP), Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), and Border Gateway Protocol (BGP).

Note When IP Security (IPSec) is used with GRE, the access list for encrypting traffic does not list the desired end network and applications, but instead refers to the permitted source and destination of the GRE tunnel in the outbound direction. All packets forwarded to the GRE tunnel are encrypted if no further access control lists (ACLs) are applied to the tunnel interface.

VPNs

VPN configuration information must be configured on both endpoints; for example, on your Cisco router and at the remote user, or on your Cisco router and on another router. You must specify parameters, such as internal IP addresses, internal subnet masks, DHCP server addresses, and Network Address Translation (NAT).

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure a VPN
- Configure a GRE Tunnel

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Note The procedures in this chapter assume that you have already configured basic router features as well as PPPoE or PPPoA with NAT, DCHP and VLANs. If you have not performed these configurations tasks, see Chapter 1, "Basic Router Configuration," Chapter 3, "Configuring PPP over Ethernet with NAT," Chapter 4, "Configuring PPP over ATM with NAT," and Chapter 5, "Configuring a LAN with DHCP and VLANs," as appropriate for your router.

Configure a VPN

Perform the following tasks to configure a VPN over an IPSec tunnel:

- Configure the IKE Policy
- Configure Group Policy Information
- Enable Policy Lookup
- Configure IPSec Transforms and Protocols
- Configure the IPSec Crypto Method and Parameters
- Apply the Crypto Map to the Physical Interface

Configure the IKE Policy

Perform these steps to configure the Internet Key Exchange (IKE) policy, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto isakmp policy** *priority*
	
	Example:
	`Router(config)# crypto isakmp policy 1`
	`Router(config-isakmp)#`
		Creates an IKE policy that is used during IKE negotiation. The priority is a number from 1 to 10000, with 1 being the highest.
		
		Also enters Internet Security Association Key and Management Protocol (ISAKMP) policy configuration mode.

Step 2	**encryption** {**des** | **3des** | **aes** | **aes 192** | **aes 256**}
	
	Example:
	`Router(config-isakmp)# encryption 3des`
	`Router(config-isakmp)#`
		Specifies the encryption algorithm used in the IKE policy.
		
		The example uses 168-bit Data Encryption Standard (DES).

Step 3	**hash** {**md5** | **sha**}
	
	Example:
	`Router(config-isakmp)# hash md5`
	`Router(config-isakmp)#`
		Specifies the hash algorithm used in the IKE policy.
		
		The example specifies the Message Digest 5 (MD5) algorithm. The default is Secure Hash standard (SHA-1).

Step 4	**authentication** {**rsa-sig** | **rsa-encr** | **pre-share**}
	
	Example:
	`Router(config-isakmp)# authentication pre-share`
	`Router(config-isakmp)#`
		Specifies the authentication method used in the IKE policy.
		
		The example uses a pre-shared key.

	Command or Action	Purpose

Step 5	**group** {**1** | **2** | **5**}
	
	Example:
	`Router(config-isakmp)# group 2`
	`Router(config-isakmp)#`
		Specifies the Diffie-Hellman group to be used in the IKE policy.

Step 6	**lifetime** *seconds*
	
	Example:
	`Router(config-isakmp)# lifetime 480`
	`Router(config-isakmp)#`
		Specifies the lifetime, 60–86400 seconds, for an IKE security association (SA).

Step 7	**exit**
	
	Example:
	`Router(config-isakmp)# exit`
	`Router(config)#`
		Exits IKE policy configuration mode, and enters global configuration mode.

Configure Group Policy Information

Perform these steps to configure the group policy, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto isakmp client configuration group** {**group-name** | **default**}
	
	Example:
	`Router(config)# crypto isakmp client configuration group rtr-remote`
	`Router(config-isakmp-group)#`
		Creates an IKE policy group that contains attributes to be downloaded to the remote client.
		
		Also enters Internet Security Association Key Management Protocol (ISAKMP) policy configuration mode.

Step 2	**key** *name*
	
	Example:
	`Router(config-isakmp-group)# key secret-password`
	`Router(config-isakmp-group)#`
		Specifies the IKE pre-shared key for the group policy.

Step 3	**dns** *primary-server*
	
	Example:
	`Router(config-isakmp-group)# dns 10.50.10.1`
	`Router(config-isakmp-group)#`
		Specifies the primary Domain Name Service (DNS) server for the group.
		
		Note You may also want to specify Windows Internet Naming Service (WINS) servers for the group by using the **wins** command.

	Command or Action	Purpose

Step 4	**domain** *name*
	
	Example:
	`Router(config-isakmp-group)# domain company.com`
	`Router(config-isakmp-group)#`
		Specifies group domain membership.

Step 5	**exit**
	
	Example:
	`Router(config-isakmp-group)# exit`
	`Router(config)#`
		Exits IKE group policy configuration mode, and enters global configuration mode.

Step 6	**ip local pool** {**default** | *poolname*} [*low-ip-address* [*high-ip-address*]]
	
	Example:
	`Router(config)# ip local pool dynpool 30.30.30.20 30.30.30.30`
	`Router(config)#`
		Specifies a local address pool for the group.
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Enable Policy Lookup

Perform these steps to enable policy lookup through AAA, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**aaa new-model**
	
	Example:
	`Router(config)# aaa new-model`
	`Router(config)#`
		Enables the AAA access control model.

Step 2	**aaa authentication login** {**default** | *list-name*} *method1* [*method2...*]
	
	Example:
	`Router(config)# aaa authentication login rtr-remote local`
	`Router(config)#`
		Specifies AAA authentication of selected users at login, and specifies the method used.
		This example uses a local authentication database. You could also use a RADIUS server for this. See the *Cisco IOS Security Configuration Guide* and the *Cisco IOS Security Command Reference* for details.

	Command or Action	Purpose

Step 3	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2*...]]
	
	Example:
	`Router(config)# aaa authorization network rtr-remote local`
	`Router(config)#`
		Specifies AAA authorization of all network-related service requests, including PPP, and the method used to do so.
		
		This example uses a local authorization database. You could also use a RADIUS server for this. See the *Cisco IOS Security Configuration Guide* and the *Cisco IOS Security Command Reference* for details.

Step 4	**username** *name* {**nopassword** | **password** *password* | **password** *encryption-type encrypted-password*}
	
	Example:
	`Router(config)# username Cisco password 0 Cisco`
	`Router(config)#`
		Establishes a username-based authentication system.
		
		This example implements a username of *Cisco* with an encrypted password of *Cisco*.

Configure IPSec Transforms and Protocols

A transform set represents a certain combination of security protocols and algorithms. During IKE negotiation, the peers agree to use a particular transform set for protecting data flow.

During IKE negotiations, the peers search in multiple transform sets for a transform that is the same at both peers. When such a transform set is found, it is selected and applied to the protected traffic as a part of both peers' configurations.

Perform these steps to specify the IPSec transform set and protocols, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*] [*transform4*]
	
	Example:
	`Router(config)# crypto ipsec transform-set vpn1 esp-3des esp-sha-hmac`
	`Router(config)#`
		Defines a transform set—An acceptable combination of IPSec security protocols and algorithms.
		
		See the *Cisco IOS Security Command Reference* for detail about the valid transforms and combinations.

Step 2	**crypto ipsec security-association lifetime** {**seconds** *seconds* | **kilobytes** *kilobytes*}
	
	Example:
	`Router(config)# crypto ipsec security-association lifetime seconds 86400`
	`Router(config)#`
		Specifies global lifetime values used when negotiating IPSec security associations.
		
		See the *Cisco IOS Security Command Reference* for details.

Note With manually established security associations, there is no negotiation with the peer, and both sides must specify the same transform set.

Configure the IPSec Crypto Method and Parameters

A dynamic crypto map policy processes negotiation requests for new security associations from remote IPSec peers, even if the router does not know all the crypto map parameters (for example, IP address).

Perform these steps to configure the IPSec crypto method, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**crypto dynamic-map** *dynamic-map-name dynamic-seq-num*
	
	Example:
	`Router(config)# crypto dynamic-map dynmap 1`
	`Router(config-crypto-map)#`
		Creates a dynamic crypto map entry, and enters crypto map configuration mode.
		
		See the *Cisco IOS Security Command Reference* for more detail about this command.

Step 2	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
	
	Example:
	`Router(config-crypto-map)# set transform-set vpn1`
	`Router(config-crypto-map)#`
		Specifies which transform sets can be used with the crypto map entry.

Step 3	**reverse-route**
	
	Example:
	`Router(config-crypto-map)# reverse-route`
	`Router(config-crypto-map)#`
		Creates source proxy information for the crypto map entry.
		
		See the *Cisco IOS Security Command Reference* for details.

Step 4	**exit**
	
	Example:
	`Router(config-crypto-map)# exit`
	`Router(config)#`
		Enters global configuration mode.

Step 5	**crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*]
	
	Example:
	`Router(config)# crypto map static-map 1 ipsec-isakmp dynamic dynmap`
	`Router(config)#`
		Creates a crypto map profile.

Apply the Crypto Map to the Physical Interface

The crypto maps must be applied to each interface through which IPSec traffic flows. Applying the crypto map to the physical interface instructs the router to evaluate all the traffic against the security associations database. With the default configurations, the router provides secure connectivity by encrypting the traffic sent between remote sites. However, the public interface still allows the rest of the traffic to pass and provides connectivity to the Internet.

Perform these steps to apply a crypto map to an interface, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 0`
	`Router(config-if)#`
		Enters interface configuration mode for the interface to which you want to apply the crypto map.

Step 2	**crypto map** *map-name*
	
	Example:
	`Router(config-if)# crypto map static-map`
	`Router(config-if)#`
		Applies the crypto map to the interface.
		
		See th e *Cisco IOS Security Command Reference* for more detail about this command.

Step 3	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Enters global configuration mode.

Configure a GRE Tunnel

Perform these steps to configure a GRE tunnel, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface tunnel 1`
	`Router(config-if)#`
		Creates a tunnel interface and enters interface configuration mode.

Step 2	**ip address** *ip-address mask*
	
	Example:
	`Router(config-if)# 10.62.1.193`
	`255.255.255.252`
	`Router(config-if)#`
		Assigns an address to the tunnel.

	Command or Action	Purpose

Step 3	**tunnel source** *interface-type number*
	
	Example:
	`Router(config-if)# tunnel source fastethernet 2`
	`Router(config-if)#`
		Specifies the source endpoint of the router for the GRE tunnel.

Step 4	**tunnel destination** *default-gateway-ip-address*
	
	Example:
	`Router(config-if)# tunnel destination 192.168.101.1`
	`Router(config-if)#`
		Specifies the destination endpoint of the router for the GRE tunnel.

Step 5	**crypto map** *map-name*
	
	Example:
	`Router(config-if)# crypto map static-map`
	`Router(config-if)#`
		Assigns a crypto map to the tunnel.
		
		Note Dynamic routing or static routes to the tunnel interface must be configured to establish connectivity between the sites. See the *Cisco IOS Security Configuration Guide* for details.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits interface configuration mode, and returns to global configuration mode.

Step 7	**ip access-list** {**standard** | **extended**} *access-list-name*
	
	Example:
	`Router(config)# ip access-list extended vpnstatic1`
	`Router(config-acl)#`
		Enters ACL configuration mode for the named ACL that is used by the crypto map.

Step 8	**permit** *protocol source source-wildcard destination destination-wildcard*
	
	Example:
	`Router(config-acl)# permit gre host 192.168.100.1 host 192.168.101.1`
	`Router(config-acl)#`
		Specifies that only GRE traffic is permitted on the outbound interface.

Step 9	**exit**
	
	Example:
	`Router(config-acl)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Configuration Example

The following configuration example shows a portion of the configuration file for a VPN using a GRE tunnel scenario described in the preceding sections.

```
!
aaa new-model
!
aaa authentication login rtr-remote local
aaa authorization network rtr-remote local
aaa session-id common
!
username cisco password 0 cisco
!
interface tunnel 1
    ip address 10.62.1.193 255.255.255.252

tunnel source fastethernet 2

tunnel destination interface 192.168.101.1

ip route 20.20.20.0 255.255.255.0 tunnel 1

crypto isakmp policy 1
    encryption 3des
    authentication pre-share
    group 2
!
crypto isakmp client configuration group rtr-remote
    key secret-password
    dns 10.50.10.1 10.60.10.1
    domain company.com
    pool dynpool
!
crypto ipsec transform-set vpn1 esp-3des esp-sha-hmac
!
crypto ipsec security-association lifetime seconds 86400
!
crypto dynamic-map dynmap 1
    set transform-set vpn1
    reverse-route
!
crypto map static-map 1 ipsec-isakmp dynamic dynmap
crypto map dynmap isakmp authorization list rtr-remote
crypto map dynmap client configuration address respond
!
crypto isakmp policy 1 ! defines the key association and authentication for ipsec tunnel.
hash md5
authentication pre-share
crypto isakmp key cisco123 address 200.1.1.1
!
!
crypto ipsec transform-set set1 esp-3des esp-md5-hmac ! defines encryption and transform
set for the ipsec tunnel.
!
crypto map to_corporate 1 ipsec-isakmp ! associates all crypto values and peering address
for the ipsec tunnel.
 set peer 200.1.1.1
 set transform-set set1
 match address 105
!
!!
interface vlan 1 ! VLAN 1 is the internal home network
```

```
 ip address 10.1.1.1 255.255.255.0
 ip nat inside
 ip inspect firewall in ! inspection examines outbound traffic
 crypto map static-map
 no cdp enable
!
interface fastethernet 0! FE0 is the outside or internet exposed interface
 ip address 210.110.101.21 255.255.255.0
 ip access-group 103 in ! acl 103 permits ipsec traffic from the corp. router as well as
denies internet initiated traffic inbound.
 ip nat outside
 no cdp enable
 crypto map to_corporate ! applies the ipsec tunnel to the outside interface.
!
ip nat inside source list 102 interface Ethernet1 overload ! utilize nat overload in order
to make best use of the single address provided by the isp.
ip classless
ip route 0.0.0.0 0.0.0.0 210.110.101.1
no ip http server
!
!
! acl 102 associated addresses used for nat.
access-list 102 permit ip 10.1.1.0 0.0.0.255 any
! acl 103 defines traffic allowed from the peer for the ipsec tunnel.
access-list 103 permit udp host 200.1.1.1 any eq isakmp
access-list 103 permit udp host 200.1.1.1 eq isakmp any
access-list 103 permit esp host 200.1.1.1 any
access-list 103 permit icmp any any ! allow icmp for debugging but should be disabled due
to security implications.
access-list 103 deny ip any any ! prevents internet initiated traffic inbound.
! acl 105 matches addresses for the ipsec tunnel to/from the corporate network.
access-list 105 permit ip 10.1.1.0 0.0.0.255 192.168.0.0 0.0.255.255
no cdp run
```

Configuring a Simple Firewall

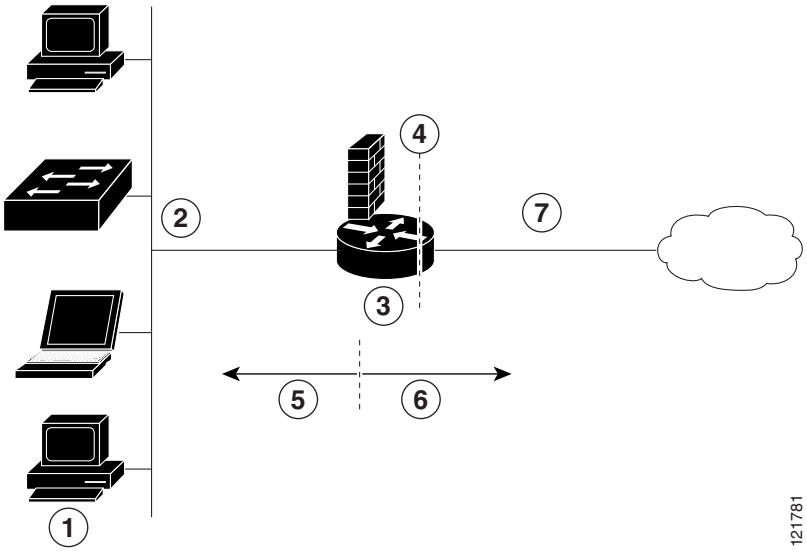
The Cisco 1800 integrated services routers support network traffic filtering by means of access lists. The router also supports packet inspection and dynamic temporary access lists by means of Context-Based Access Control (CBAC).

Basic traffic filtering is limited to configured access list implementations that examine packets at the network layer or, at most, the transport layer, permitting or denying the passage of each packet through the firewall. However, the use of inspection rules in CBAC allows the creation and use of dynamic temporary access lists. These dynamic lists allow temporary openings in the configured access lists at firewall interfaces. These openings are created when traffic for a specified user session exits the internal network through the firewall. The openings allow returning traffic for the specified session (that would normally be blocked) back through the firewall.

See the *Cisco IOS Security Configuration Guide, Release 12.3*, for more detailed information on traffic filtering and firewalls.

Figure 8-1 shows a network deployment using PPPoE or PPPoA with NAT and a firewall.

Figure 8-1 Router with Firewall Configured



1	Multiple networked devices—Desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (the inside interface for NAT)
3	PPPoE or PPPoA client and firewall implementation—Cisco 1811/1812 or Cisco 1801/1802/1803 series integrated services router, respectively
4	Point at which NAT occurs
5	Protected network
6	Unprotected network
7	Fast Ethernet or ATM WAN interface (the outside interface for NAT)

In the configuration example that follows, the firewall is applied to the outside WAN interface (FE0) on the Cisco 1811 or Cisco 1812 and protects the Fast Ethernet LAN on FE2 by filtering and inspecting all traffic entering the router on the Fast Ethernet WAN interface FE1. Note that in this example, the network traffic originating from the corporate network, network address 10.1.1.0, is considered safe traffic and is not filtered.

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure Access Lists
- Configure Inspection Rules
- Apply Access Lists and Inspection Rules to Interfaces

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Note The procedures in this chapter assume that you have already configured basic router features as well as PPPoE or PPPoA with NAT. If you have not performed these configurations tasks, see Chapter 1, "Basic Router Configuration," Chapter 3, "Configuring PPP over Ethernet with NAT," and Chapter 4, "Configuring PPP over ATM with NAT," as appropriate for your router. You may have also configured DHCP, VLANs, and secure tunnels.

Configure Access Lists

Perform these steps to create access lists for use by the firewall, beginning in global configuration mode:

	Command	Purpose

Step 1	**access-list** *access-list-number* {**deny** | **permit**} *protocol source source-wildcard* [**operator** [*port*]] *destination*
	
	Example:
	`Router(config)# access-list 103 permit host 200.1.1.1 eq isakmp any`
	`Router(config)#`
		Creates an access list which prevents Internet-initiated traffic from reaching the local (inside) network of the router, and which compares source and destination ports.
		
		See the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services* for details about this command.

Step 2	**access-list** *access-list-number* {**deny** | **permit**} *protocol source source-wildcard destination destination-wildcard*
	
	Example:
	`Router(config)# access-list 105 permit ip 10.1.1.0 0.0.0.255 192.168.0.0 0.0.255.255`
	`Router(config)#`
		Creates an access list that allows network traffic to pass freely between the corporate network and the local networks through the configured VPN tunnel.

Configure Inspection Rules

Perform these steps to configure firewall inspection rules for all TCP and UDP traffic, as well as specific application protocols as defined by the security policy, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**ip inspect name** *inspection-name protocol*
	
	Example:
	`Router(config)# ip inspect name firewall tcp`
	`Router(config)#`
		Defines an inspection rule for a particular protocol.

Step 2	**ip inspect name** *inspection-name protocol*
	
	Example:
	`Router(config)# ip inspect name firewall rtsp`
	`Router(config)# ip inspect name firewall h323`
	`Router(config)# ip inspect name firewall netshow`
	`Router(config)# ip inspect name firewall ftp`
	`Router(config)# ip inspect name firewall sqlnet`
	`Router(config)#`
		Repeat this command for each inspection rule that you wish to use.

Apply Access Lists and Inspection Rules to Interfaces

Perform these steps to apply the ACLs and inspection rules to the network interfaces, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config-if)#`
		Enters interface configuration mode for the inside network interface on your router.

Step 2	**ip inspect** *inspection-name* {**in** | **out**}
	
	Example:
	`Router(config-if)# ip inspect firewall in`
	`Router(config-if)#`
		Assigns the set of firewall inspection rules to the inside interface on the router.

Step 3	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Step 4	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 0`
	`Router(config-if)#`
		Enters interface configuration mode for the outside network interface on your router.

Step 5	**ip access-group** {*access-list-number* | *access-list-name*} {**in** | **out**}
	
	Example:
	`Router(config-if)# ip access-group 103 in`
	`Router(config-if)#`
		Assigns the defined ACLs to the outside interface on the router.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Returns to global configuration mode.

Configuration Example

A telecommuter is granted secure access to a corporate network, using IPSec tunneling. Security to the home network is accomplished through firewall inspection. The protocols that are allowed are all TCP, UDP, RTSP, H.323, NetShow, FTP, and SQLNet. There are no servers on the home network; therefore, no traffic is allowed that is initiated from outside. IPSec tunneling secures the connection from the Home LAN to the corporate network.

Like the Internet Firewall Policy, HTTP need not be specified because Java blocking is not necessary. Specifying TCP inspection allows for single-channel protocols such as Telnet and HTTP. UDP is specified for DNS.

The following configuration example shows a portion of the configuration file for the simple firewall scenario described in the preceding sections.

```
! Firewall inspection is setup for all tcp and udp traffic as well as specific application
protocols as defined by the security policy.
ip inspect name firewall tcp
ip inspect name firewall udp
ip inspect name firewall rtsp
ip inspect name firewall h323
ip inspect name firewall netshow
ip inspect name firewall ftp
ip inspect name firewall sqlnet
!
interface vlan 1! This is the internal home network
ip inspect firewall in ! inspection examines outbound traffic
    no cdp enable
!
interface fastethernet 0! FE0 is the outside or internet exposed interface.
ip access-group 103 in ! acl 103 permits ipsec traffic from the corp. router as well as
denies internet initiated traffic inbound.
    ip nat outside
    no cdp enable
!
! acl 103 defines traffic allowed from the peer for the ipsec tunnel.
access-list 103 permit udp host 200.1.1.1 any eq isakmp
access-list 103 permit udp host 200.1.1.1 eq isakmp any
access-list 103 permit esp host 200.1.1.1 any
access-list 103 permit icmp any any ! allow icmp for debugging but should be disabled due
to security implications.
access-list 103 deny ip any any ! prevents internet initiated traffic inbound.
! acl 105 matches addresses for the ipsec tunnel to/from the corporate network.
access-list 105 permit ip 10.1.1.0 0.0.0.255 192.168.0.0 0.0.255.255
no cdp run
!
```

Configuring a Wireless LAN Connection

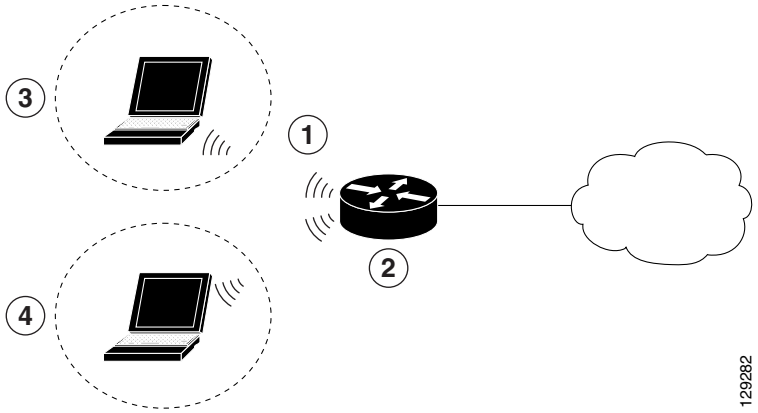
The Cisco 1800 series integrated services fixed-configuration routers support a secure, affordable, and easy-to-use wireless LAN solution that combines mobility and flexibility with the enterprise-class features required by networking professionals. With a management system based on Cisco IOS software, the Cisco routers act as access points, and are Wi-Fi certified, IEEE 802.11a/b/g-compliant wireless LAN transceivers.

You can configure and monitor the routers using the command-line interface (CLI), the browser-based management system, or Simple Network Management Protocol (SNMP). This chapter describes how to configure the router using the CLI. Use the **interface dot11radio** global configuration CLI command to place the device into radio configuration mode.

See the *Cisco Access Router Wireless Configuration Guide* for more detailed information about configuring these Cisco routers in a wireless LAN application.

Figure 9-1 shows a wireless network deployment.

Figure 9-1 Sample Wireless LAN



1	Wireless LAN (with multiple networked devices)
2	Cisco 1800 series integrated services router connected to the Internet
3	VLAN 1
4	VLAN 2

In the configuration example that follows, a remote user is accessing the Cisco 1800 series integrated services router using a wireless connection. Each remote user has his own VLAN.

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure the Root Radio Station
- Configure Bridging on VLANs
- Configure Radio Station Subinterfaces

An example showing the results of these configuration tasks is shown in the section "Configuration Example."

Note The procedures in this chapter assume that you have already configured basic router features as well as PPPoE or PPPoA with NAT. If you have not performed these configurations tasks, see Chapter 1, "Basic Router Configuration," Chapter 3, "Configuring PPP over Ethernet with NAT," and Chapter 4, "Configuring PPP over ATM with NAT," as appropriate for your router. You may have also configured DHCP, VLANs, and secure tunnels.

Configure the Root Radio Station

Perform these steps to create and configure the root radio station for your wireless LAN, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *name number*
	
	Example:
	`Router(config)# interface dot11radio 0`
	`Router(config-if)#`
		Enters interface configuration mode for the specified wireless interface.

Step 2	**broadcast-key** [[**vlan** *vlan-id*] **change** *secs*] [**membership-termination**] [**capability-change**]
	
	Example:
	`Router(config-if)# broadcast-key vlan 1 change 45`
	`Router(config-if)#`
		Specifies the time interval (in seconds) between rotations of the broadcast encryption key used for clients.
		
		Note Client devices using static Wired Equivalent Privacy (WEP) cannot use the access point when you enable broadcast key rotation—only wireless client devices using 802.1x authentication (such as Light Extensible Authentication Protocol [LEAP], Extensible Authentication Protocol-Transport Layer Security [EAP-TLS], or Protected Extensible Authentication Protocol [PEAP]) can use the access point.
		
		Note This command is not supported on bridges.
		
		See the *Cisco IOS Commands for Access Points and Bridges* document for more details.

	Command	Purpose

Step 3	**encryption** *method algorithm key*
	
	Example:
	`Router(config-if)# encryption vlan 1 mode ciphers tkip`
	`Router(config-if)#`
		Specifies the encryption method, algorithm, and key used to access the wireless interface.
		
		The example uses the VLAN with optional encryption method of data ciphers.

Step 4	**ssid** *name*
	
	Example:
	`Router(config-if)# ssid cisco`
	`Router(config-if-ssid)#`
		Creates a Service Set ID (SSID), the public name of a wireless network.
		
		Note All of the wireless devices on a WLAN must employ the same SSID to communicate with each other.

Step 5	**vlan** *number*
	
	Example:
	`Router(config-if-ssid)# vlan 1`
	`Router(config-if-ssid)#`
		Binds the SSID with a VLAN.

Step 6	**authentication** *type*
	
	Example:
	`Router(config-if-ssid)# authentication open`
	`Router(config-if-ssid)# authentication network-eap eap_methods`
	`Router(config-if-ssid)# authentication key-management wpa`
		Sets the permitted authentication methods for a user attempting access to the wireless LAN.
		
		More than one method can be specified, as shown in the example.

Step 7	**exit**
	
	Example:
	`Router(config-if-ssid)# exit`
	`Router(config-if)#`
		Exits SSID configuration mode, and enters interface configuration mode for the wireless interface.

Step 8	**speed** *rate*
	
	Example:
	`Router(config-if)# basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0 24.0 36.0 48.0 54.0`
	`Router(config-if)#`
		(Optional) Specifies the required and allowed rates, in Mbps, for traffic over the wireless connection.

Step 9	**rts** [**retries** | **threshold**]
	
	Example:
	`Router(config-if)# rts threshold 2312`
	`Router(config-if)#`
		(Optional) Specifies the Request to Send (RTS) threshold or the number of times to send a request before determining the wireless LAN is unreachable.

	Command	Purpose

Step 10	**power** [**client** | **local**] [**cck** [*number* | **maximum**] | **ofdm** [*number* | **maximum**]]
	
	Example:
	`Router(config-if)# power local cck 50`
	`Router(config-if)# power local ofdm 30`
	`Router(config-if)#`
		(Optional) Specifies the radio transmitter power level.
		
		See the *Cisco Access Router Wireless Configuration Guide* for available power level values.

Step 11	**channel** [*number* | **least-congested**]
	
	Example:
	`Router(config-if)# channel 2462`
	`Router(config-if)#`
		(Optional) Specifies the channel on which communication occurs.
		
		See the *Cisco Access Router Wireless Configuration Guide* for available channel numbers.

Step 12	**station-role** [**repeater** | **root**]
	
	Example:
	`Router(config-if)# station-role root`
	`Router(config-if)#`
		(Optional) Specifies the role of this wireless interface.
		
		You must specify at least one root interface.

Step 13	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits interface configuration mode, and enters global configuration mode.

Configure Bridging on VLANs

Perform these steps to configure integrated routing and bridging on VLANs, beginning in global configuration mode:

	Command or Action	Purpose

Step 1	**bridge** [*number* | **crb** | **irb** |**mac-address-table**]
	
	Example:
	`Router(config)# bridge irb`
	`Router(config)#`
		Specifies the type of bridging.
		
		The example specifies integrated routing and bridging.

Step 2	**interface** *name number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config)#`
		Enters interface configuration mode.
		
		We want to set up bridging on the VLANs, so the example enters the VLAN interface configuration mode.

	Command or Action	Purpose

Step 3	**bridge-group** *number*
	
	Example:
	`Router(config)# bridge-group 1`
	`Router(config)#`
		Assigns a bridge group to the interface.

Step 4	**bridge-group** *parameter*
	
	Example:
	`Router(config)# bridge-group spanning-disabled`
	`Router(config)#`
		Sets other bridge parameters for the bridging interface.

Step 5	**interface** *name number*
	
	Example:
	`Router(config)# interface bvi 1`
	`Router(config)#`
		Enters configuration mode for the virtual bridge interface.

Step 6	**ip address** *address mask*
	
	Example:
	`Router(config)# ip address 10.0.1.1 255.255.255.0`
	`Router(config)#`
		Specifies the address for the virtual bridge interface.

Repeat Step 2 through Step 6 above for each VLAN that requires a wireless interface.

Configure Radio Station Subinterfaces

Perform these steps to configure subinterfaces for each root station, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface dot11radio 0.1`
	`Router(config-subif)#`
		Enters subinterface configuration mode for the root station interface.

Step 2	**description** *string*
	
	Example:
	`Router(config-subif)# description Cisco open`
	`Router(config-subif)#`
		Provides a description of the subinterface for the administrative user.

	Command	Purpose

Step 3	**encapsulation dot1q** *vlanID* [**native** | **second-dot1q**]
	
	Example:
	`Router(config-subif)# encapsulation dot1q 1 native`
	`Router(config-subif)#`
		Enables IEEE 802.1q encapsulation on the specified subinterface.

Step 4	**no cdp enable**
	
	Example:
	`Router(config-subif)# no cdp enable`
	`Router(config-subif)#`
		Disables the Cisco Discovery Protocol (CDP) on the wireless interface.

Step 5	**bridge-group** *number*
	
	Example:
	`Router(config-subif)# bridge-group 1`
	`Router(config-subif)#`
		Assigns a bridge group to the subinterface.

Step 6	**exit**
	
	Example:
	`Router(config-subif)# exit`
	`Router(config)#`
		Exits subinterface configuration mode, and enters global configuration mode.

Repeat these steps to configure more subinterfaces, as needed.

Configuration Example

The following configuration example shows a portion of the configuration file for the wireless LAN scenario described in the preceding sections.

```
!
bridge irb
!
interface Dot11Radio0
 no ip address
 !
 broadcast-key vlan 1 change 45
 !
 !
 encryption vlan 1 mode ciphers tkip
 !
 ssid cisco
    vlan 1
    authentication open
    authentication network-eap eap_methods
    authentication key-management wpa
 !
 ssid ciscowep
    vlan 2
```

```
   authentication open
 !
 ssid ciscowpa
   vlan 3
   authentication open
 !
 speed basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0 24.0 36.0 48.0 54.0
 rts threshold 2312
 power local cck 50
 power local ofdm 30
 channel 2462
 station-role root
!
interface Dot11Radio0.1
 description Cisco Open
 encapsulation dot1Q 1 native
 no cdp enable
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
 bridge-group 1 block-unknown-source
 no bridge-group 1 source-learning
 no bridge-group 1 unicast-flooding
!
interface Dot11Radio0.2
 encapsulation dot1Q 2
 bridge-group 2
 bridge-group 2 subscriber-loop-control
 bridge-group 2 spanning-disabled
 bridge-group 2 block-unknown-source
 no bridge-group 2 source-learning
 no bridge-group 2 unicast-flooding
!
interface Dot11Radio0.3
 encapsulation dot1Q 3
 bridge-group 3
 bridge-group 3 subscriber-loop-control
 bridge-group 3 spanning-disabled
 bridge-group 3 block-unknown-source
 no bridge-group 3 source-learning
 no bridge-group 3 unicast-flooding
!
interface Vlan1
 no ip address
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface Vlan2
 no ip address
 bridge-group 2
 bridge-group 2 spanning-disabled
!
interface Vlan3
 no ip address
 bridge-group 3
 bridge-group 3 spanning-disabled
!
interface BVI1
 ip address 10.0.1.1 255.255.255.0
!
interface BVI2
 ip address 10.0.2.1 255.255.255.0
```

```
!
interface BVI3
 ip address 10.0.3.1 255.255.255.0
!
```

Sample Configuration

This chapter collects the results of the Ethernet WAN interface, DHCP, VLAN, Easy VPN, and wireless interface configurations made in previous chapters. This allows you to view what a basic configuration provided by this guide looks like in a single sample, Example 10-1.

Note Commands marked by "**(default)**" are generated automatically when you run the **show running-config** command.

Example 10-1 Sample Configuration

```
Router# show running-config
Building configuration...

Current configuration : 3781 bytes
!
version 12.3
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname retail
!
boot-start-marker
boot-end-marker
!
enable password cisco123
!
username jsomeone password 0 cg6#107X
aaa new-model
!
aaa group server radius rad_eap
    server 10.0.1.1 auth-port 1812 acct-port 1813
!
aaa authentication login eap_methods group rad_eap
aaa session-id common
ip subnet-zero
ip cef
!
vpdn enable
    vpdn-group 1
    request-dialin
    protocol pppoe
!
interface dialer 1
```

```
    ip address negotiated
    ppp authentication chap
    dialer pool 1
    dialer-group 1
!
dialer-list 1 protocol ip permit
    ip nat inside source list 1 interface dialer 0 overload
    ip classless (default)
    ip route 10.10.25.2 0.255.255.255 dialer 0
!
ip dhcp excluded-address 10.0.1.1 10.0.1.10
ip dhcp excluded-address 10.0.2.1 10.0.2.10
ip dhcp excluded-address 10.0.3.1 10.0.3.10
!
ip dhcp pool vlan1
   network 10.0.1.0 255.255.255.0
   default-router 10.0.1.1
!
ip dhcp pool vlan2
   network 10.0.2.0 255.255.255.0
   default-router 10.0.2.1
!
ip dhcp pool vlan3
   network 10.0.3.0 255.255.255.0
   default-router 10.0.3.1
!
ip ips po max-events 100
no ftp-server write-enable
!
bridge irb
!
interface FastEthernet2
    no ip address
!
interface FastEthernet3
    no ip address
!
interface FastEthernet4
    no ip address
!
interface FastEthernet5
    no ip address
!
interface FastEthernet6
    no ip address
!
interface FastEthernet7
    no ip address
!
interface FastEthernet8
    no ip address
!
interface FastEthernet9
    switchport mode trunk
    no ip address
!
interface FastEthernet0
    ip address 192.1.12.2 255.255.255.0
    no ip directed-broadcast (default)
    ip nat outside
    ip access-group 103 in
    no cdp enable
    crypto ipsec client ezvpn ezvpnclient outside
    crypto map static-map
```

```
    duplex auto
    speed auto
!
interface FastEthernet1
    no ip address
    duplex auto
    speed auto
!
crypto isakmp policy 1
    encryption 3des
    authentication pre-share
    group 2
    lifetime 480
!
crypto isakmp client configuration group rtr-remote
    key secret-password
    dns 10.50.10.1 10.60.10.1
    domain company.com
    pool dynpool
!
crypto ipsec transform-set vpn1 esp-3des esp-sha-hmac
!
crypto ipsec security-association lifetime seconds 86400
!
crypto dynamic-map dynmap 1
    set transform-set vpn1
    reverse-route
!
crypto map static-map 1 ipsec-isakmp dynamic dynmap
crypto map dynmap isakmp authorization list rtr-remote
crypto map dynmap client configuration address respond

crypto ipsec client ezvpn ezvpnclient
    connect auto
    group 2 key secret-password
    mode client
    peer 192.168.100.1
!
interface Dot11Radio0
    no ip address
    !
    broadcast-key vlan 1 change 45
    !
    encryption vlan 1 mode ciphers tkip
    !
    ssid cisco
        vlan 1
        authentication open
        authentication network-eap eap_methods
        authentication key-management wpa optional
    !
    ssid ciscowep
        vlan 2
        authentication open
        !
    ssid ciscowpa
        vlan 3
        authentication open
    !
    speed basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0 24.0 36.0 48.0 54.0
    rts threshold 2312
    power local cck 50
    power local ofdm 30
    channel 2462
```

```
    station-role root
!
interface Dot11Radio0.1
    description Cisco Open
    encapsulation dot1Q 1 native
    no cdp enable
    bridge-group 1
    bridge-group 1 subscriber-loop-control
    bridge-group 1 spanning-disabled
    bridge-group 1 block-unknown-source
    no bridge-group 1 source-learning
    no bridge-group 1 unicast-flooding
!
interface Dot11Radio0.2
    encapsulation dot1Q 2
    bridge-group 2
    bridge-group 2 subscriber-loop-control
    bridge-group 2 spanning-disabled
    bridge-group 2 block-unknown-source
    no bridge-group 2 source-learning
    no bridge-group 2 unicast-flooding
!
interface Dot11Radio0.3
    encapsulation dot1Q 3
    bridge-group 3
    bridge-group 3 subscriber-loop-control
    bridge-group 3 spanning-disabled
    bridge-group 3 block-unknown-source
    no bridge-group 3 source-learning
    no bridge-group 3 unicast-flooding
!
interface Vlan1
    ip address 192.168.1.1 255.255.255.0
    no ip directed-broadcast (default)
    ip nat inside
    crypto ipsec client ezvpn ezvpnclient inside
    ip inspect firewall in
    no cdp enable
    bridge-group 1
    bridge-group 1 spanning-disabled
!
interface Vlan2
    no ip address
    bridge-group 2
    bridge-group 2 spanning-disabled
!
interface Vlan3
    no ip address
    bridge-group 3
    bridge-group 3 spanning-disabled
!
interface BVI1
    ip address 10.0.1.1 255.255.255.0
!
interface BVI2
    ip address 10.0.2.1 255.255.255.0
!
interface BVI3
    ip address 10.0.3.1 255.255.255.0
!
ip classless
!
ip http server
no ip http secure-server
```

```
!
radius-server local
    nas 10.0.1.1 key 0 cisco123
    group rad_eap
!
user jsomeone nthash 7 0529575803696F2C492143375828267C7A760E11137346244527257O7C010B065B
user AMER\jsomeone nthash 7
0224550C29232E041C6A5D3C5633305D5D560C0902796616713723302658OE0B0D
!
radius-server host 10.0.1.1 auth-port 1812 acct-port 1813 key cisco123
!
control-plane
!
bridge 1 route ip
bridge 2 route ip
bridge 3 route ip
!
ip inspect name firewall tcp
ip inspect name firewall udp
ip inspect name firewall rtsp
ip inspect name firewall h323
ip inspect name firewall netshow
ip inspect name firewall ftp
ip inspect name firewall sqlnet
!
access-list 103 permit udp host 200.1.1.1 any eq isakmp
access-list 103 permit udp host 200.1.1.1 eq isakmp any
access-list 103 permit esp host 200.1.1.1 any
access-list 103 permit icmp any any
access-list 103 deny ip any any
access-list 105 permit ip 10.1.1.0 0.0.0.255 192.168.0.0 0.0.255.255
no cdp run
!
line con 0
    password cisco123
    no modem enable
    transport preferred all
    transport output all
line aux 0
    transport preferred all
    transport output all
line vty 0 4
    password cisco123
    transport preferred all
    transport input all
    transport output all
!
```

Cisco Systems

PART 3

Configuring Additional Features and Troubleshooting

Additional Configuration Options

This part of the software configuration guide describes additional configuration options and troubleshooting tips for the Cisco 1800 series integrated services fixed configuration routers (Cisco 1801, Cisco 1802, Cisco 1803, Cisco 1811, and Cisco 1812).

The configuration options described in this part include:

- Chapter 12, "Configuring Security Features"
- Chapter 13, "Configuring Dial Backup and Remote Management"
- Chapter 14, "Troubleshooting"

The descriptions contained in these chapters do not describe all of your configuration or troubleshooting needs. See the appropriate Cisco IOS configuration guides and command references for additional details.

Note To verify that a specific feature is compatible with your router, you can use the Software Advisor tool. You can access this tool at **www.cisco.com > Technical Support & Documentation > Tools & Resources** with your Cisco username and password.

CHAPTER 12

Configuring Security Features

This chapter gives an overview of authentication, authorization, and accounting (AAA), the primary Cisco framework for implementing selected security features that can be configured on the Cisco 1800 integrated services fixed-configuration routers.

Note Individual router models may not support every feature described throughout this guide. Features not supported by a particular router are indicated whenever possible.

This chapter contains the following sections:

Each section includes a configuration example and verification steps, where available.

Authentication, Authorization, and Accounting

AAA network security services provide the primary framework through which you set up access control on your router. Authentication provides the method of identifying users, including login and password dialog, challenge and response, messaging support, and, depending on the security protocol you choose, encryption. Authorization provides the method for remote access control, including one-time authorization or authorization for each service, per-user account list and profile, user group support, and support of IP, Internetwork Packet Exchange (IPX), AppleTalk Remote Access (ARA), and Telnet. Accounting provides the method for collecting and sending security server information used for billing, auditing, and reporting, such as user identities, start and stop times, executed commands (such as PPP), number of packets, and number of bytes.

AAA uses protocols such as RADIUS, TACACS+, or Kerberos to administer its security functions. If your router is acting as a network access server, AAA is the means through which you establish communication between your network access server and your RADIUS, TACACS+, or Kerberos security server.

For information about configuring AAA services and supported security protocols, see the following sections of the *Cisco IOS Security Configuration Guide:*

- Configuring Authentication
- Configuring Authorization
- Configuring Accounting
- Configuring RADIUS
- Configuring TACACS+
- Configuring Kerberos

Configuring AutoSecure

The AutoSecure feature disables common IP services that can be exploited for network attacks and enables IP services and features that can aid in the defense of a network when under attack. These IP services are all disabled and enabled simultaneously with a single command, greatly simplifying security configuration on your router. For a complete description of the AutoSecure feature, see the "AutoSecure" feature document.

Configuring Access Lists

Access lists (ACLs) permit or deny network traffic over an interface based on source IP address, destination IP address, or protocol. Access lists are configured as standard or extended. A standard access list either permits or denies passage of packets from a designated source. An extended access list allows designation of both the destination and the source, and it allows designation of individual protocols to be permitted or denied passage. An access list is a series of commands with a common tag to bind them together. The tag is either a number or a name. Table 12-1 lists the commands used to configure access lists.

Table 12-1 Access List Configuration Commands

ACL Type	Configuration Commands
Numbered	
Standard	**access-list** {**1-99**}{**permit** | **deny**} *source-addr* [*source-mask*]
Extended	**access-list** {**100-199**}{**permit** | **deny**} *protocol source-addr* [*source-mask*] *destination-addr* [*destination-mask*]
Named	
Standard	**ip access-list standard** *name* followed by **deny** {*source* | *source-wildcard* | **any**}
Extended	**ip access-list extended** *name* followed by {**permit** | **deny**} *protocol* {*source-addr* [*source-mask*] | **any**}{*destination-addr* [*destination-mask*] | **any**}

Access Groups

A sequence of access list definitions bound together with a common name or number is called an access group. An access group is enabled for an interface during interface configuration with the following command:

ip access-group *number* | *name* [**in** | **out**]

where **in** | **out** refers to the direction of travel of the packets being filtered.

Guidelines for Creating Access Groups

Use the following guidelines when creating access groups.

- The order of access list definitions is significant. A packet is compared against the first access list in the sequence. If there is no match (that is, if neither a permit nor a deny occurs), the packet is compared with the next access list, and so on.
- All parameters must match the access list before the packet is permitted or denied.
- There is an implicit "deny all" at the end of all sequences.

For more complete information on creating access lists, see the "Access Control Lists: Overview and Guidelines" section of the *Cisco IOS Release 12.3 Security Configuration Guide*.

Configuring a CBAC Firewall

Context-Based Access Control (CBAC) lets you configure a stateful firewall where packets are inspected internally and the state of network connections is monitored. This is superior to static access lists, because access lists can only permit or deny traffic based on individual packets, not streams of packets. Also, because CBAC inspects the packets, decisions to permit or deny traffic can be made by examining application layer data, something static access lists cannot do.

To configure a CBAC firewall, specify which protocols to examine by using the following command in interface configuration mode:

ip inspect name *inspection-name protocol* **timeout** *seconds*

When inspection detects that the specified protocol is passing through the firewall, a dynamic access list is created to allow the passage of return traffic. The **timeout** parameter specifies the length of time the dynamic access list remains active without return traffic passing through the router. When the timeout value is reached, the dynamic access list is removed, and subsequent packets (possibly valid ones) are not permitted.

Use the same inspection name in multiple statements to group them into one set of rules. This set of rules can be activated elsewhere in the configuration by using the **ip inspect** *inspection-name* **in** | **out** command when you configure an interface at the firewall.

See Chapter 8, "Configuring a Simple Firewall," for a sample configuration. For additional information about configuring a CBAC firewall, see the "Configuring Context-Based Access Control" section of the *Cisco IOS Release 12.3 Security Configuration Guide*.

Configuring Cisco IOS Firewall IDS

Cisco IOS Firewall Intrusion Detection System (IDS) technology enhances perimeter firewall protection by taking appropriate action on packets and flows that violate the security policy or represent malicious network activity.

Cisco IOS Firewall IDS identifies 59 of the most common attacks using "signatures" to detect patterns of misuse in network traffic. It acts as an in-line intrusion detection sensor, watching packets and sessions as they flow through the router, scanning each to match any of the IDS signatures. When it detects suspicious activity, it responds before network security can be compromised, logs the event, and, depending on configuration, sends an alarm, drops suspicious packets, or resets the TCP connection.

For additional information about configuring Cisco IOS Firewall IDS, see the "Configuring Cisco IOS Firewall Intrusion Detection System" section of the *Cisco IOS Release 12.3 Security Configuration Guide*.

Configuring VPNs

A virtual private network (VPN) connection provides a secure connection between two networks over a public network such as the Internet. Cisco 1800 series fixed-configuration access routers support site-to-site VPNs using IP security (IPSec) tunnels and generic routing encapsulation (GRE). Permanent VPN connections between two peers, or dynamic VPNs using EZVPN or DMVPN which create and tear down VPN connections as needed, can be configured. Chapter 6, "Configuring a VPN Using Easy VPN and an IPSec Tunnel," and Chapter 7, "Configuring VPNs Using an IPSec Tunnel and Generic Routing Encapsulation," show examples of how to configure your router with these features. For more information about IPSec and GRE configuration, see the "Configuring IPSec Network Security" chapter of the *Cisco IOS Release 12.3 Security Configuration Guide*.

For information about additional VPN configurations supported by Cisco 1800 series fixed-configuration access routers, see the following feature documents:

- "VPN Access Control Using 802.1X Authentication"—802.1X authentication allows enterprise employees to access their enterprise networks from home while allowing other household members to access only the Internet.
- "EZVPN Server"—Cisco 1800 series fixed-configuration routers can be configured to act as EZVPN servers, letting authorized EZVPN clients establish dynamic VPN tunnels to the connected network.
- "Dynamic Multipoint VPN (DMVPN)"—The DMVPN feature creates VPN tunnels between multiple routers in a multipoint configuration as needed, simplifying the configuration and eliminating the need for permanent, point-to-point VPN tunnels.

Configuring Dial Backup and Remote Management

The Cisco 1800 integrated services fixed-configuration routers support dial-in (for remote management) and dial-out (for dial backup) capabilities. By allowing you to configure a backup modem line connection, the Cisco 1800 integrated services fixed-configuration routers provide protection against WAN downtime. Dial backup is inactive by default, and must be configured to be active.

Dial backup and remote management functions are configured through the ISDN S/T port of the Cisco 1812, Cisco 1801, Cisco 1802, and Cisco 1803 routers. These functions are configured through the V.92 modem port of the Cisco 1811 router.

This chapter contains the following topics:

Dial Backup Feature Activation Methods

Three methods are available to activate the dial backup feature:

Backup Interfaces

When the router receives an indication that the primary line is down, a backup interface is brought up. You can configure the backup interface to go down once the primary connection has been restored for a specified period.

This is accomplished using dial-on-demand routing (DDR). When this is configured, a backup call is triggered by specified traffic.

Note Even if the backup interface comes out of standby mode (is brought up), the router does not trigger the backup call unless it receives the specified traffic for that backup interface.

Configuring Backup Interfaces

Perform these steps to configure your router with a backup interface, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface atm 0`
	`Router(config-if)#`
		Enters interface configuration mode for the interface for which you want to configure backup.
		
		This can be a serial interface, ISDN interface, or asynchronous interface.
		
		The example shows the configuration of a backup interface for an ATM WAN connection.

Step 2	**backup interface** *interface-type interface-number*
	
	Example:
	`Router(config-if)# backup interface bri 0`
	`Router(config-if)#`
		Assigns an interface as the secondary, or backup interface.
		
		This can be a serial interface or asynchronous interface. For example, a serial 1 interface could be configured to back up a serial 0 interface.
		
		The example shows a Basic Rate Interface configured as the backup interface for the ATM 0 interface.

Step 3	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Enters global configuration mode.

Floating Static Routes

Floating static routes provide alternative routes for traffic. Floating static routes are not activated unless a DDR backup call has been triggered by specified traffic for a backup interface.

Floating static routes are independent of line protocol status. This is an important consideration for Frame Relay circuits because the line protocol may not go down if the data-link connection identifier (DLCI) is inactive. Floating static routes are also encapsulation independent.

Note When static routes are configured, the primary interface protocol must go down in order to activate the floating static route.

Configuring Floating Static Routes

Static and dynamic routes are the two components of floating static routes. Perform these steps to configure the static and dynamic routes on your router, beginning in global configuration mode:

	Command	Purpose

Step 1	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]}
	
	Example:
	`Router(config)# ip route 0.0.0.0 0.0.0.0 22.0.0.2`
	`Router(config)#`
		Assigns the primary static route.

Step 2	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*]
	
	Example:
	`Router(config)# ip route 0.0.0.0 0.0.0.0 192.168.2.2 150`
	`Router(config)#`
		Assigns the lower routing administrative distance value for the backup interface route. 192.168.2.2 is the peer IP address of the backup interface.

Step 3	**router rip**
	
	Example:
	`Router(config)# router rip`
	`Router(config)#`
		Enables RIP routing.

Step 4	**network** *ip-address*
	
	Example:
	`Router(config)# network 22.0.0.0`
	`Router(config)#`
		Defines the primary interface network. 22.0.0.0 is the network value of the primary interface.

Step 5	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*]
	
	Example:
	`Router(config)# ip route 0.0.0.0 0.0.0.0 192.168.2.2 150`
	`Router(config)#`
		Assigns the lower routing administrative distance value for the backup interface route. 192.168.2.2 is the peer IP address of the backup interface.

Note When dynamic routing is activated, the floating static route depends upon routing protocol convergence times.

Dialer Watch

The dialer watch method only supports the Extended Interior Gateway Routing Protocol (EIGRP) link-state dynamic routing protocols.

Configuring Dialer Watch

Perform these steps to configure a dialer watch on your router, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface dialer 2`
	`Router(config-if)#`
		Enters configuration mode for the dial backup interface.

Step 2	**dialerwatch-group** *group-number*
	
	Example:
	`Router(config-if)# dialer watch-group 2`
	`Router(config-if)#`
		Specifies the group number for the watch list.

Step 3	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Enters global configuration mode.

Step 4	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*]
	
	Example:
	`Router(config)# ip route 0.0.0.0 0.0.0.0 22.0.0.2`
	`Router(config)#`
		Assigns the primary route. 22.0.0.2 is the peer IP address of the primary interface.

	Command	Purpose

Step 5	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*]
	
	Example:
	`Router(config)# ip route 0.0.0.0 0.0.0.0 192.168.2.2 150`
	`Router(config)#`
		Assigns the lower routing administrative distance value for the backup interface route. 192.168.2.2 is the peer IP address of the backup interface.

Step 6	**dialerwatch-list** *group-number* {**ip** *ip-address address-mask* | **delay route-check initial** *seconds*}
	
	Example:
	`Router(config)# dialer watch-list 2 ip 22.0.0.2 255.255.255.255`
	`Router(config)#`
		Assigns an IP address to the watch list.
		
		If the connection on the primary interface is lost and the IP address is unavailable on the router, the dial-out feature on the backup interface is triggered. 22.0.0.2 is the peer IP address of the primary interface.

Dial Backup Feature Limitations

The following limitation exists for the dial backup feature: bridging is not supported over console or auxiliary port backup interfaces.

Table 13-1 summarizes dial backup support and limitations for the Cisco 1800 series integrated services fixed-configuration routers.

Table 13-1 Dial Backup Feature Support and Limitations Summary

WAN Encapsulation Type	Dial Backup Possible?	Dial Backup Method	Limitations
Cisco 1811 or Cisco 1812			
PPPoE	Yes	Dialer watch	Bridging is not supported across a slow interface, for example, an auxiliary port. The peer IP address of the ISP is needed to configure the **dialerwatch** command and the IP static route.
Normal IP in cable modem scenario	No	Dialer watch	The IP addresses of the peers are needed for dialer watch to work properly. If a lease time obtained by DHCP is not set short enough (1 or 2 minutes), dial backup is not supported.

Table 13-1 Dial Backup Feature Support and Limitations Summary (continued)

WAN Encapsulation Type	Dial Backup Possible?	Dial Backup Method	Limitations
Cisco 1801, Cisco 1802, or Cisco 1803			
PPP over ATM PPP over Ethernet	Yes	Backup interfaces Floating static routes Dialer watch	Floating static route and dialer watch need a routing protocol to run in the router. The dialer watch method brings up the backup interface as soon as the primary link goes down. The backup interface is brought down as soon as the dialer timeout is reached and the primary interface is up. The router checks the primary interface only when the dialer timeout expires. The backup interface remains up until the dialer timeout is reached, even though the primary interface is up. For the dialer watch method, a routing protocol does not need to be running in the router, if the IP address of the peer is known.
RFC 1483 (AAL5, SNAP, and MUX)	Yes	Backup interfaces Floating static routes Dialer watch	If bridging is done through the WAN interface, it is not supported across the auxiliary port.

Configuration Example

The following three examples show sample configurations for the three dial backup methods.

Example 13-1 Configuring Dial Backup Using Backup Interfaces

```
!
vpdn enable
!
vpdn-group 1
accept-dialin
protocol pppoe
!
!Specifies the ISDN switch type
isdn switch-type basic-net3
!
interface vlan 1
ip address 192.168.1.1 255.255.255.0
hold-queue 100 out
!
!ISDN interface to be used as a backup interface
interface BRI0
no ip address
encapsulation ppp
dialer pool-member 1
isdn switch-type basic-net3
!
interface ATM0
backup interface BRI0
no ip address
no atm ilmi-keepalive
pvc 1/40
encapsulation aal5snap
pppoe-client dial-pool-number 2
```

```
!
dsl operating-mode auto
!
! Dial backup interface, associated with physical BRI0 interface. Dialer pool 1 associates
it with BRI0's dialer pool member 1
interface Dialer0
ip address negotiated
encapsulation ppp
dialer pool 1
dialer idle-timeout 30
dialer string 384040
dialer-group 1
!
! Primary interface associated with physical ATM0's interface, dialer pool 2 associates it
with ATM0's dial-pool-number2
interface Dialer2
ip address negotiated
ip mtu 1492
encapsulation ppp
dialer pool 2
dialer-group 2
no cdp enable
!
ip classless
!Primary and backup interface given route metric
ip route 0.0.0.0 0.0.0.0 22.0.0.2
ip route 0.0.0.0 0.0.0.0 192.168.2.2 80
ip http server
!
!Specifies interesting traffic to trigger backup ISDN traffic
dialer-list 1 protocol ip permit
```

Example 13-2 Configuring Dial Backup Using Floating Static Routes

```
!
vpdn enable
!
vpdn-group 1
accept-dialin
protocol pppoe
!
!Specifies the ISDN switch type
isdn switch-type basic-net3
!
interface vlan 1
ip address 192.168.1.1 255.255.255.0
hold-queue 100 out
!
!ISDN interface to be used as a backup interface
interface BRI0
no ip address
encapsulation ppp
dialer pool-member 1
isdn switch-type basic-net3
!
interface ATM0
no ip address
no atm ilmi-keepalive
pvc 1/40
encapsulation aal5snap
pppoe-client dial-pool-number 2
!
```

```
dsl operating-mode auto
!
! Dial backup interface, associated with physical BRI0 interface. Dialer pool 1 associates
it with BRI0's dialer pool member 1
interface Dialer0
ip address negotiated
encapsulation ppp
dialer pool 1
dialer idle-timeout 30
dialer string 384040
dialer-group 1
!
! Primary interface associated with physical ATM0's interface, dialer pool 2 associates it
with ATM0's dial-pool-number2
interface Dialer2
ip address negotiated
ip mtu 1492
encapsulation ppp
dialer pool 2
dialer-group 2
!
ip classless
no cdp enable
!Primary and backup interface given route metric (This example using static routes, thus
atm0 line protocol must be brought down for backup interface to function.)
ip route 0.0.0.0 0.0.0.0 22.0.0.2
ip route 0.0.0.0 0.0.0.0 192.168.2.2 150
ip http server
!
!Specifies interesting traffic to trigger backup ISDN traffic
dialer-list 1 protocol ip permit
```

Example 13-3 Configuring Dial Backup Using Dialer Watch

```
!
vpdn enable
!
vpdn-group 1
accept-dialin
protocol pppoe
!
!Specifies the ISDN switch type
isdn switch-type basic-net3
!
interface Ethernet0
ip address 192.168.1.1 255.255.255.0
hold-queue 100 out
!
!ISDN interface to be used as a backup interface
interface BRI0
no ip address
encapsulation ppp
dialer pool-member 1
isdn switch-type basic-net3
!
interface ATM0
no ip address
no atm ilmi-keepalive
pvc 1/40
encapsulation aal5snap
pppoe-client dial-pool-number 2
!
```

```
dsl operating-mode auto
!
! Dial backup interface, associated with physical BRI0 interface. Dialer pool 1 associates
it with BRI0's dialer pool member 1. Note "dialer watch-group 1" associates a watch list
with corresponding "dialer watch-list" command
interface Dialer0
ip address negotiated
encapsulation ppp
dialer pool 1
dialer idle-timeout 30
dialer string 384040
dialer watch-group 1
dialer-group 1
!
! Primary interface associated with physical ATM0 interface, dialer pool 2 associates it
with ATM0's dial-pool-number2
interface Dialer2
ip address negotiated
ip mtu 1492
encapsulation ppp
dialer pool 2
dialer-group 2
no cdp enable
!
ip classless

!Primary and backup interface given route metric
ip route 0.0.0.0 0.0.0.0 22.0.0.2
ip route 0.0.0.0 0.0.0.0 192.168.2.2 80
ip http server
!
!Watch for interesting traffic
dialer watch-list 1 ip 22.0.0.2 255.255.255.255

!Specifies interesting traffic to trigger backup ISDN traffic
dialer-list 1 protocol ip permit
!
```

Configuring Dial Backup and Remote Management Through the ISDN S/T Port

The Cisco 1812, Cisco 1801, Cisco 1802, and Cisco 1803 routers use the ISDN S/T port for dial backup and remote management. Perform the following tasks to configure dial backup and remote management through the ISDN S/T port of your router:

- Configure ISDN Settings
- Configure the Aggregator and ISDN Peer Router

Configure ISDN Settings

Note Traffic of interest must be present to activate the backup ISDN line by means of the backup interface and floating static routes methods. Traffic of interest is not needed for the dialer watch to activate the backup ISDN line.

Perform these steps to configure your router ISDN interface for use as a backup interface, beginning in global configuration mode:

	Command	Purpose

Step 1	**isdn switch-type** *switch-type*
	
	Example:
	`Router(config)# isdn switch-type basic-net3`
	`Router(config)#`
		Specifies the ISDN switch type.
		
		The example specifies a switch type used in Australia, Europe, and the United Kingdom. For details on other switch types supported, see the *Cisco IOS Dial Technologies Command Reference*.

Step 2	**interface** *type number*
	
	Example:
	`Router(config)# interface bri 0`
	`Router(config-if)#`
		Enters configuration mode for the ISDN Basic Rate Interface (BRI).

Step 3	**encapsulation** *encapsulation-type*
	
	Example:
	`Router(config-if)# encapsulation ppp`
	`Router(config-if)#`
		Sets the BRI0 interface encapsulation type.

Step 4	**dialer pool-member** *number*
	
	Example:
	`Router(config-if)# dialer pool-member 1`
	`Router(config-if)#`
		Specifies the dialer pool membership.

Step 5	**isdn switch-type** *switch-type*
	
	Example:
	`Router(config-if)# isdn switch-type basic-net3`
	`Router(config-if)#`
		Specifies the ISDN switch type.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Enters global configuration mode.

Step 7	**interface dialer** *dialer-rotary-group-number*
	
	Example:
	`Router(config)# interface dialer 0`
	`Router(config-if)#`
		Creates a dialer interface (numbered 0–255) and enters into interface configuration mode.

	Command	Purpose

Step 8	**ip address negotiated**
	
	Example:
	`Router(config-if)# ip address negotiated`
	`Router(config-if)#`
		Specifies that the IP address for the interface is obtained through PPP/IPCP (IP Control Protocol) address negotiation. The IP address is obtained from the peer.

Step 9	**encapsulation** *encapsulation-type*
	
	Example:
	`Router(config-if)# encapsulation ppp`
	`Router(config-if)#`
		Sets the encapsulation type to PPP for the interface.

Step 10	**dialer pool** *number*
	
	Example:
	`Router(config-if)# dialer pool 1`
	`Router(config-if)#`
		Specifies the dialer pool to be used.
		
		In the example, the dialer pool 1 setting associates the dialer 0 interface with the BRI0 interface because the BRI0 dialer pool-member value is 1.

Step 11	**dialer string** *dial-string*[**:***isdn-subaddress*]
	
	Example:
	`Router(config-if)# dialer string 384040`
	`Router(config-if)#`
		Specifies the telephone number to be dialed.

Step 12	**dialer-group** *group-number*
	
	Example:
	`Router(config-if)# dialer group 1`
	`Router(config-if)#`
		Assigns the dialer interface to a dialer group (1–10).

Step 13	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits the dialer 0 interface configuration mode, and enters global configuration mode.

Step 14	**dialer-list** *dialer-group* **protocol** *protocol-name* {**permit** | **deny** | **list** *access-list-number* | **access-group**}
	
	Example:
	`Router(config)# dialer-list 1 protocol ip permit`
	`Router(config)#`
		Creates a dialer list for packets of interest to be forwarded through the specified interface dialer group.
		
		In the example, dialer-list 1 corresponds to dialer-group 1.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Dial Technologies Command Reference*.

Configure the Aggregator and ISDN Peer Router

The aggregator is typically a concentrator router where your Cisco router ATM PVC terminates. In the configuration example shown below, the aggregator is configured as a PPPoE server to correspond with the Cisco 876 router configuration example that is given in this chapter.

The ISDN peer router is any router that has an ISDN interface and can communicate through a public ISDN network to reach your Cisco router ISDN interface. The ISDN peer router provides Internet access for your Cisco router during the ATM network downtime.

```
!This portion of the example configures the aggregator
vpdn enable
no vpdn logging
!
vpdn-group 1
accept-dialin
protocol pppoe
virtual-template 1
!
interface Ethernet3
description "4700ref-1"
ip address 40.1.1.1 255.255.255.0
media-type 10BaseT
!
interface Ethernet4
ip address 30.1.1.1 255.255.255.0
media-type 10BaseT
!
interface Virtual-Template1
ip address 22.0.0.2 255.255.255.0
ip mtu 1492
peer default ip address pool adsl
!
interface ATM0
no ip address
pvc 1/40
encapsulation aal5snap
protocol pppoe
!
no atm limi-keepalive
!
ip local pool adsl 22.0.0.1
ip classless
ip route 0.0.0.0 0.0.0.0 22.0.0.1 50
ip route 0.0.0.0 0.0.0.0 30.1.1.2.80

!This portion of the example configures the ISDN peer
isdn switch-type basic-net3
!
interface Ethernet0
ip address 30.1.1.2 255.0.0.0
!
interface BRI0
description "to 836-dialbackup"
no ip address
encapsulation ppp
dialer pool-member 1
isdn switch-type basic-net3
!
interface Dialer0
ip address 192.168.2.2 255.255.255.0
encapsulation ppp
dialer pool 1
```

```
dialer string 384020
dialer-group 1
peer default ip address pool isdn
!
ip local pool isdn 192.168.2.1
ip http server
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.2.1
ip route 40.0.0.0 255.0.0.0 30.1.1.1
!
dialer-list 1 protocol ip permit
!
```

Configuring Dial Backup and Remote Management Through a V.92 Modem

Perform the following tasks to configure dial backup and remote management through the V.92 modem on your Cisco 1811 router:

- Asynchronous Interface Configuration
- Line Configuration

Asynchronous Interface Configuration

Perform these steps to configure the V.92 modem for use as a backup interface, beginning in global configuration mode:

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface async 1`
	`Router(config-if)#`
		Enters interface configuration mode for the asynchronous serial interface. Enter the number of the interface you want to configure.

Step 2	**ip unnumbered** *type number*
	
	Example:
	`Router(config-if)# ip unnumbered FastEthernet 2`
	`Router(config-if)#`
		Conserves IP addresses by configuring the asynchronous interface as unnumbered, and assigns the IP address of the interface type that you want to leverage.

Step 3	**encapsulation** *encapsulation-type*
	
	Example:
	`Router(config-if)# encapsulation ppp`
	`Router(config-if)#`
		Sets the encapsulation type to PPP for the interface.

	Command	Purpose

Step 4	**dialer in-band**
	
	Example:
	`Router(config-if)# dialer in-band`
	`Router(config-if)#`
		Specifies support for dial-on-demand routing (DDR) and chat scripts on this asynchronous interface.

Step 5	**dialer string** *dial-string*
	
	Example:
	`Router(config-if)# dialer string T14085551234`
	`Router(config-if)#`
		Specifies the telephone number to be dialed.

Step 6	**dialer-group** *group-number*
	
	Example:
	`Router(config-if)# dialer group 1`
	`Router(config-if)#`
		Assigns the dialer interface to a dialer group (1–10), controlling access. The number to which the dialer access group belongs is defined with the **dialer-list** command.

Step 7	**async mode interactive**
	
	Example:
	`Router(config-if)# async mode interactive`
	`Router(config-if)#`
		Returns a line that has been placed into dedicated asynchronous network mode to interactive mode, thereby enabling the Serial Line Internet Protocol (SLIP) and PPP EXEC commands.

Step 8	**peer default ip address** {*ip-address* | **pool** [*pool-name*]}
	
	Example:
	`Router(config-if)# peer default ip address pool pool123`
	`Router(config-if)#`
		Assigns IP addresses to remote clients, using an address pool. To create an IP address pool, use the **ip local pool** global configuration command.

Step 9	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits asynchronous interface configuration, and enters global configuration mode.

Line Configuration

Perform these steps to configure the line on the V.92 modem, beginning in global configuration mode:

	Command	Purpose

Step 1	**line** *line-number*
	
	Example:
	`Router(config)# line 1`
	`Router(config-line)`
		Identifies a specific line for configuration and enters line configuration collection mode.
		
		Note The number entered here must be the same as the number entered for the asynchronous serial interface.

Step 2	**modem inout**
	
	Example:
	`Router(config-line)# modem inout`
	`Router(config-line)#`
		Configures the line for both incoming and outgoing calls.

Step 3	**autoselect** {**arap** | **ppp** | **slip** | **during-login** | **timeout** *seconds*}
	
	Example:
	`Router(config-line)# autoselect ppp`
	`Router(config-line)#`
		Configures the line to automatically start an AppleTalk Remote Access (ARA), PPP, or SLIP session.
		
		Note We recommend *ppp* for use with the dial backup feature.

Step 4	**transport input** {**all** | **lat** | **mop** | **nasi** | **none** | **pad** | **rlogin** | **telnet** | **v120**}
	
	Example:
	`Router(config-line)# transport input all`
	`Router(config-line)#`
		Defines which protocols can be used to connect to the line.
		
		Note We recommend *all* for use with the dial backup feature.

Step 5	**exit**
	
	Example:
	`Router(config-line)# exit`
	`Router(config)#`
		Exits line configuration mode, and enters global configuration mode.

Troubleshooting

Use the information in this chapter to help isolate problems you might encounter or to rule out the router as the source of a problem. This chapter contains the following sections:

Getting Started

Before troubleshooting a software problem, you must connect a terminal or PC to the router using the light-blue console port. (For information on making this connection, see the documentation listed in the "Related Documents" section on page 14.) With a connected terminal or PC, you can view status messages from the router and enter commands to troubleshoot a problem.

You can also remotely access the interface (Ethernet, ADSL, or telephone) by using Telnet. The Telnet option assumes that the interface is up and running.

Before Contacting Cisco or Your Reseller

If you cannot locate the source of a problem, contact your local reseller for advice. Before you call, you should have the following information ready:

- Chassis type and serial number
- Maintenance agreement or warranty information
- Type of software and version number
- Date you received the hardware
- Brief description of the problem

- Brief description of the steps you have taken to isolate the problem

ADSL Troubleshooting

If you experience trouble with the ADSL connection, verify the following:

- The ADSL line is connected and is using pins 3 and 4. For more information on the ADSL connection, see the hardware guide for your router.
- The ADSL CD LED is on. If it is not on, the router may not be connected to the DSL access multiplexer (DSLAM). For more information on the ADSL LEDs, see the hardware installation guide specific for your router.
- The correct Asynchronous Transfer Mode (ATM) virtual path indentifier/virtual circuit identifier (VPI/VCI) is being used.
- The DSLAM supports discrete multi-tone (DMT) Issue 2.
- The ADSL cable that you connect to the Cisco router must be 10BASE-T Category 5, unshielded twisted-pair (UTP) cable. Using regular telephone cable can introduce line errors.

SHDSL Troubleshooting

Symmetrical high-data-rate digital subscriber line (SHDSL) is available on the Cisco 1803 router model. If you experience trouble with the SHDSL connection, verify the following:

- The SHDSL line is connected and using pins 3 and 4. For more information on the G.SHDSL connection, see the hardware guide for your router.
- The G.SHDSL LED is on. If it is not on, the router may not be connected to the DSL access multiplexer (DSLAM). For more information on the G.SHDSL LED, see the hardware installation guide specific for your router.
- The correct asynchronous transfer mode (ATM) virtual path indentifier/virtual circuit identifier (VPI/VCI) is being used.
- The DSLAM supports the G.SHDSL signaling protocol.

Use the **show controllers dsl 0** command in privileged EXEC mode to view an SHDSL configuration.

PortFast Troubleshooting

PortFast is a feature that you typically enable for a port or interface that connects to a host. When the link comes up on this port, the bridge skips the first stages of the STA and directly transitions to forwarding mode.

If you use the PortFast feature on switch ports or interfaces that connect to other switches, hubs, or routers, a network loop might get created. If the looped traffic is heavy, the bridge might experience problems with the successful transmission of the BPDU that stops the loop. This problem could delay convergence, or in extreme cases, bring down the network.

Caution Do not use the PortFast feature on switch ports or interfaces that connect to other switches, hubs, or routers. Otherwise, you might create a network loop.

For details, see the "PortFast Configuration Error" section in the *Spanning Tree Protocol Problems and Related Design Considerations* document.

ATM Troubleshooting Commands

Use the following commands to troubleshoot your ATM interface.

- ping atm interface Command
- show interface Command
- show atm interface Command
- debug atm Commands

ping atm interface Command

Use the **ping atm interface** command to determine whether a particular PVC is in use. The PVC does not need to be configured on the router to use this command. Example 14-1 shows the use of this command to determine whether PVC 8/35 is in use.

Example 14-1 Determining If a PVC Is in Use

```
Router# ping atm interface atm 0 8 35 seg-loopback

Type escape sequence to abort.
Sending 5, 53-byte segment OAM echoes, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 148/148/148 ms


!----This command sends five OAM F5 loopback packets to the DSLAM (segment OAM packets).
If the PVC is configured at the DSLAM, the ping is successful.

!----To test whether the PVC is being used at the aggregator, enter the following command:

Router# ping atm interface atm 0 8 35 end-loopback

Type escape sequence to abort.
Sending 5, 53-byte end-to-end OAM echoes, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 400/401/404 ms

!----This command sends end-to-end OAM F5 packets, which are echoed back by the
aggregator.
```

show interface Command

Use the **show interface** command to display the status of all physical ports (Ethernet and ATM) and logical interfaces on the router. Example 14-2 shows sample command output.

Example 14-2 Viewing the Status of Selected Interfaces

```
Router# show interface atm 0
ATM0 is up, line protocol is up
```

```
  Hardware is PQUICC_SAR (with Alcatel ADSL Module)
  Internet address is 14.0.0.16/8
  MTU 1500 bytes, sub MTU 1500, BW 640 Kbit, DLY 80 usec,
     reliability 40/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s):AAL5, PVC mode
  10 maximum active VCs, 1 current VCCs
  VC idle disconnect time:300 seconds
  Last input 01:16:31, output 01:16:31, output hang never
  Last clearing of "show interface" counters never
  Input queue:0/75/0 (size/max/drops); Total output drops:0
  Queueing strategy:Per VC Queueing
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     512 packets input, 59780 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 1024 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     426 packets output, 46282 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out

Router# show interface fastethernet 0
Ethernet0 is up, line protocol is up
Hardware is PQUICC Ethernet, address is 0000.0c13.a4db
(bia0010.9181.1281)
Internet address is 170.1.4.101/24
MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
    reliability 255/255., txload 1/255, rxload 1/255
    Encapsulation ARPA, loopback not set
    Keepalive set (10 sec)

Router# show interface dialer 1
Dialer 1 is up, line protocol is up
    Hardware is Dialer interface
    Internet address is 1.1.1.1/24
    MTU 1500 bytes, BW 100000 Kbit, DLY 100000 usec, reliability
        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 Closed
```

Table 14-1 describes possible command output for the **show interface** command.

Table 14-1 show interface Command Output Description

Output	Cause
For ATM Interfaces	
ATM 0 is up, line protocol is up	The ATM line is up and operating correctly.
ATM 0 is down, line protocol is down	• The ATM interface has been disabled with the **shutdown** command or • The ATM line is down, possibly because the ADSL cable is disconnected or because the wrong type of cable is connected to the ATM port.

Table 14-1 show interface Command Output Description (continued)

Output	Cause
ATM 0.*n* is up, line protocol is up	The specified ATM subinterface is up and operating correctly.
ATM 0.*n* is administratively down, line protocol is down	The specified ATM subinterface has been disabled with the **shutdown** command.
ATM 0.*n* is down, line protocol is down	The specified ATM subinterface is down, possibly because the ATM line has been disconnected (by the service provider).
For Fast Ethernet Interfaces	
Fast Ethernet *n* is up, line protocol is up	The specified Fast Ethernet interface is connected to the network and operating correctly.
Fast Ethernet *n* is up, line protocol is down	The specified Fast Ethernet interface has been correctly configured and enabled, but the Ethernet cable might be disconnected from the LAN.
Fast Ethernet *n* is administratively down, line protocol is down	The specified Fast Ethernet interface has been disabled with the **shutdown** command, and the interface is disconnected.
For Dialer Interfaces	
Dialer *n* is up, line protocol is up	The specified dialer interface is up and operating correctly.
Dialer *n* is down, line protocol is down	• This is a standard message and may not indicate anything is actually wrong with the configuration or • If you are having problems with the specified dialer interface, this can mean it is not operating, possibly because the interface has been brought down with the **shutdown** command, or the ADSL cable is disconnected.

show atm interface Command

To display ATM-specific information about an ATM interface, use the **show atm interface atm 0** command from privileged EXEC mode, as shown in Example 14-3.

Example 14-3 Viewing Information About an ATM Interface

```
Router# show atm interface atm 0
Interface ATM0:
AAL enabled:  AAL5   AAL2, Maximum VCs: 23, Current VCCs: 0

VCIs per VPI: 1024,
Max. Datagram Size: 4528
PLIM Type: ADSL - 4608Kbps Upstream, DMT, TX clocking: LINE
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 4608
Config. is ACTIVE
```

Table 14-2 describes some of the fields shown in the command output.

Table 14-2 show atm interface Command Output Description

Field	Description
ATM interface	Interface number. Always 0 for the Cisco 1800 fixed-configuration routers.
AAL enabled	Type of AAL enabled. The Cisco 1800 fixed-configuration routers support AAL5.
Maximum VCs	Maximum number of virtual connections this interface supports.
Current VCCs	Number of active virtual channel connections (VCCs).
Maximum Transmit Channels	Maximum number of transmit channels.
Max Datagram Size	Configured maximum number of bytes in the largest datagram.
PLIM Type	Physical layer interface module (PLIM) type.

debug atm Commands

Use the **debug** commands to troubleshoot configuration problems that you might be having on your network. The **debug** commands provide extensive, informative displays to help you interpret any possible problems.

Guidelines for Using Debug Commands

Read the following guidelines before using debug commands to ensure appropriate results.

- All debug commands are entered in privileged EXEC mode.
- To view debugging messages on a console, enter the **logging console debug** command.
- Most **debug** commands take no arguments.
- To disable debugging, enter the **undebug all** command.
- To use **debug** commands during a Telnet session on your router, enter the **terminal monitor** command.

Caution Debugging is assigned a high priority in your router CPU process, and it can render your router unusable. For this reason, use **debug** commands only to troubleshoot specific problems. The best time to use debug commands is during periods of low network traffic so that other activity on the network is not adversely affected.

You can find additional information and documentation about the **debug** commands in the *Cisco IOS Debug Command Reference*.

debug atm errors Command

Use the **debug atm errors** command to display ATM errors. The **no** form of this command disables debugging output. Example 14-4 shows a sample output.

Example 14-4 Viewing ATM Errors

```
Router# debug atm errors
ATM errors debugging is on
Router#
01:32:02:ATM(ATM0.2):VC(3) Bad SAP received 4500
01:32:04:ATM(ATM0.2):VC(3) Bad SAP received 4500
01:32:06:ATM(ATM0.2):VC(3) Bad SAP received 4500
01:32:08:ATM(ATM0.2):VC(3) Bad SAP received 4500
01:32:10:ATM(ATM0.2):VC(3) Bad SAP received 4500
```

debug atm events Command

Use the **debug atm events** command to display events that occur on the ATM interface processor and to diagnose problems in an ATM network. This command provides an overall picture of the stability of the network. The **no** form of this command disables debugging output.

If the interface is successfully communicating with the Digital Subscriber Line Access Multiplexer (DSLAM) at the telephone company, the modem state is 0x10. If the interface is not communicating with the DSLAM, the modem state is 0x8. Example 14-5 shows an ADSL line that is up and communicating successfully. Example 14-6 shows an ADSL line that is not communicating correctly. Note that the modem state does not transition to 0x10.

Example 14-5 Viewing ATM Interface Processor Events—Success

```
Router# debug atm events
Router#
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Sent command 0x5
00:02:57: DSL: Received response: 0x26
00:02:57: DSL: Unexpected response 0x26
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Sent command 0x5
00:03:00: DSL: 1: Modem state = 0x8
00:03:02: DSL: 2: Modem state = 0x10
00:03:05: DSL: 3: Modem state = 0x10
00:03:07: DSL: 4: Modem state = 0x10
00:03:09: DSL: Received response: 0x24
00:03:09: DSL: Showtime!
00:03:09: DSL: Sent command 0x11
00:03:09: DSL: Received response: 0x61
00:03:09: DSL: Read firmware revision 0x1A04
00:03:09: DSL: Sent command 0x31
00:03:09: DSL: Received response: 0x12
00:03:09: DSL: operation mode 0x0001
00:03:09: DSL: SM: [DMTDSL_DO_OPEN -> DMTDSL_SHOWTIME]
```

Example 14-6 Viewing ATM Interface Processor Events—Failure

```
Router# debug atm events
Router#
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
```

```
00:02:57: DSL: Sent command 0x5
00:02:57: DSL: Received response: 0x26
00:02:57: DSL: Unexpected response 0x26
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Sent command 0x5
00:03:00: DSL: 1: Modem state = 0x8
00:03:00: DSL: 1: Modem state = 0x8
00:03:00: DSL: 1: Modem state = 0x8
00:03:00: DSL: 1: Modem state = 0x8
00:03:00: DSL: 1: Modem state = 0x8
00:03:00: DSL: 1: Modem state = 0x8
```

debug atm packet Command

Use the **debug atm packet** command to display all process-level ATM packets for both outbound and inbound packets. The output reports information online when a packet is received or a transmission is attempted. The **no** form of this command disables debugging output.

Caution Because the **debug atm packet** command generates a significant amount of output for every packet processed, use it only when network traffic is low, so that other system activities are not adversely affected.

The command syntax is:

debug atm packet [**interface atm** *number* [**vcd** *vcd-number*] [**vc** *vpi/vci number*]]

no debug atm packet [**interface atm** *number* [**vcd** *vcd-number*] [**vc** *vpi/vci number*]]

where the keywords are defined as follows:

interface atm *number* (Optional) ATM interface or subinterface number.

vcd *vcd-number* (Optional) Number of the virtual circuit designator (VCD).

vc *vpi/vci number* VPI/VCI value of the ATM PVC.

Example 14-7 shows a sample output.

Example 14-7 Viewing ATM Packet Processing

```
Router# debug atm packet
Router#
01:23:48:ATM0(O):
VCD:0x1 VPI:0x1 VCI:0x64 DM:0x0 SAP:AAAA CTL:03 OUI:000000 TYPE:0800 Length:0x70
01:23:48:4500 0064 0008 0000 FF01 9F80 0E00 0010 0E00 0001 0800 A103 0AF3 17F7 0000
01:23:48:0000 004C BA10 ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD
01:23:48:ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD
01:23:48:ABCD ABCD ABCD ABCD ABCD
01:23:48:
01:23:48:ATM0(I):
VCD:0x1 VPI:0x1 VCI:0x64 Type:0x0 SAP:AAAA CTL:03 OUI:000000 TYPE:0800 Length:0x70
01:23:48:4500 0064 0008 0000 FE01 A080 0E00 0001 0E00 0010 0000 A903 0AF3 17F7 0000
01:23:48:0000 004C BA10 ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD
01:23:48:ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD ABCD
01:23:48:ABCD ABCD ABCD ABCD ABCD
01:23:48:
```

Table 14-3 describes some of the fields shown in the **debug atm packet** command output.

Table 14-3 debug atm packet Command Output Description

Field	Description
ATM0	Interface that is generating the packet.
(O)	Output packet. (I) would mean receive packet.
VCD: 0x*n*	Virtual circuit associated with this packet, where *n* is some value.
VPI: 0x*n*	Virtual path identifier for this packet, where *n* is some value.
DM: 0x*n*	Descriptor mode bits, where *n* is some value.
Length: *n*	Total length of the packet (in bytes) including the ATM headers.

Software Upgrade Methods

Several methods are available for upgrading software on the Cisco 1800 series integrated services fixed-configuration routers, including:

- Copy the new software image to flash memory over the LAN or WAN while the existing Cisco IOS software image is operating.
- Copy the new software image to flash memory over the LAN while the boot image (ROM monitor) is operating.
- Copy the new software image over the console port while in ROM monitor mode.
- From ROM monitor mode, boot the router from a software image that is loaded on a TFTP server. To use this method, the TFTP server must be on the same LAN as the router.

Recovering a Lost Password

To recover a lost enable or lost enable-secret password:

1. Change the Configuration Register
2. Reset the Router
3. Reset the Password and Save Your Changes (for lost enable secret passwords only)
4. Reset the Configuration Register Value

Note Recovering a lost password is only possible when you are connected to the router through the console port. These procedures cannot be performed through a Telnet session.

Tip See the “Hot Tips” section on Cisco.com for additional information on replacing enable secret passwords.

Change the Configuration Register

To change a configuration register, follow these steps:

Step 1 Connect an ASCII terminal or a PC running a terminal emulation program to the CONSOLE port on the rear panel of the router.

Step 2 Configure the terminal to operate at 9600 baud, 8 data bits, no parity, and 1 stop bit.

Step 3 At the privileged EXEC prompt (*router_name* #), enter the **show version** command to display the existing configuration register value (shown in bold at the bottom of this output example):

```
Router# show version
Cisco IOS Software, C180X Software (C180X-ADVENTERPRISEK9-M), Version 12.4(1.8)PI2c
ENGINEERING WEEKLY BUILD, synced to haw_t BASE_LABEL_OF_V124_2_T_THROTTLE
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Fri 27-May-05 16:14 by ccai

ROM: System Bootstrap, Version 12.3(8r)YH4, RELEASE SOFTWARE (fc1)

ng-esw1-uut1 uptime is 1 hour, 21 minutes
System returned to ROM by power-on
System image file is "flash:bootimage.ng-esw1-uut1"


This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to
export@cisco.com.

Cisco 1801 (MPC8500) processor (revision 0x200) with 118784K/12288K bytes of memory.
Processor board ID FHK091412QA, with hardware revision 0000

9 FastEthernet interfaces
1 ISDN Basic Rate interface
1 ATM interface
31360K bytes of ATA CompactFlash (Read/Write)

Configuration register is 0x2102
```

Step 4 Record the setting of the configuration register.

Step 5 Enter the **config-register** *value* command to set the new configuration register value. For example, to enable the break setting (indicated by the value of bit 8 in the configuration register), enter the **config-register 0x01** command from privileged EXEC mode.

- Break enabled—Bit 8 is set to 0.
- Break disabled (default setting)—Bit 8 is set to 1.

Reset the Router

To reset the router, follow these steps:

Step 1 If break is enabled, go to Step 2. If break is disabled, turn the router off (O), wait 5 seconds, and turn it on (|) again. Within 60 seconds, press the **Break** key. The terminal displays the ROM monitor prompt. Go to Step 3.

Note Some terminal keyboards have a key labeled *Break*. If your keyboard does not have a Break key, see the documentation that came with the terminal for instructions on how to send a break.

Step 2 Press **break**. The terminal displays the following prompt:

```
rommon 2>
```

Step 3 Enter **confreg 0x142** to reset the configuration register:

```
rommon 2> confreg 0x142
```

Step 4 Initialize the router by entering the **reset** command:

```
rommon 2> reset
```

The router cycles its power, and the configuration register is set to 0x142. The router uses the boot ROM system image, indicated by the system configuration dialog:

```
--- System Configuration Dialog ---
```

Step 5 Enter **no** in response to the prompts until the following message is displayed:

```
Press RETURN to get started!
```

Step 6 Press **Return**. The following prompt appears:

```
Router>
```

Step 7 Enter the **enable** command to enter enable mode. Configuration changes can be made only in enable mode:

```
Router> enable
```

The prompt changes to the privileged EXEC prompt:

```
Router#
```

Step 8 Enter the **show startup-config** command to display an enable password in the configuration file:

```
Router# show startup-config
```

If you are recovering an enable password, omit the following "Reset the Password and Save Your Changes" section, and complete the password recovery process by performing the steps in the "Reset the Configuration Register Value" section.

If you are recovering an enable secret password, it is not displayed in the **show startup-config** command output. Complete the password recovery process by performing the steps in the following "Reset the Password and Save Your Changes" section.

Reset the Password and Save Your Changes

To reset your password and save the changes, follow these steps:

Step 1 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
```

Step 2 Enter the **enable secret** command to reset the enable secret password in the router:

```
Router(config)# enable secret password
```

Step 3 Enter **exit** to exit global configuration mode:

```
Router(config)# exit
```

Step 4 Save your configuration changes:

```
Router# copy running-config startup-config
```

Reset the Configuration Register Value

To reset the configuration register value after you have recovered or reconfigured a password, follow these steps:

Step 1 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
```

Step 2 Enter the **configure register** command and the original configuration register value that you recorded.

```
Router(config)# config-reg value
```

Step 3 Enter **exit** to exit configuration mode:

```
Router(config)# exit
```

Note To return to the configuration being used before you recovered the lost enable password, do not save the configuration changes before rebooting the router.

Step 4 Reboot the router, and enter the recovered password.

Managing Your Router with SDM

The Cisco SDM tool is a free software configuration utility, supporting the Cisco 1800 series integrated services fixed-configuration routers. It includes a web-based GUI that offers the following features:

- Simplified setup
- Advanced configuration
- Router security
- Router monitoring

Cisco Systems

Part 4

Reference Information

Cisco IOS Software Basic Skills

Understanding how to use Cisco IOS software can save you time when you are configuring your router. If you need a refresher, take a few minutes to read this appendix.

This appendix contains the following sections:

If you are already familiar with Cisco IOS software, go to one of the following chapters:

- Chapter 1, “Basic Router Configuration”
- Chapter 2, “Sample Network Deployments”
- One of the configuration topic chapters in Part 3

Configuring the Router from a PC

You can configure your router from a PC connected through the console port using *terminal emulation* software. The PC uses this software to send commands to your router. Table A-1 lists some common types of this software, which are based on the type of PC you are using.

Table A-1 Terminal Emulation Software

PC Operating System	Software
Windows 95, Windows 98, Windows 2000, Windows NT, Windows XP	HyperTerm (included with Windows software), ProComm Plus
Windows 3.1	Terminal (included with Windows software)
Macintosh	ProComm, VersaTerm (supplied separately)

You can use the terminal emulation software to change settings for the type of device that is connected to the PC, in this case a router. Configure the software to the following standard VT-100 emulation settings so that your PC can communicate with your router:

- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- No flow control

These settings should match the default settings of your router. To change the router baud, data bits, parity, or stop bits settings, you must reconfigure parameters in the ROM monitor. For more information, see Appendix C, "ROM Monitor." To change the router flow control setting, use the **flowcontrol** line configuration command.

For information on how to enter global configuration mode so that you can configure your router, see the "Entering Global Configuration Mode" section later in this chapter.

Understanding Command Modes

This section describes the Cisco IOS command mode structure. Each command mode supports specific Cisco IOS commands. For example, you can use the **interface** *type number* command only from global configuration mode.

The following Cisco IOS command modes are hierarchical. When you begin a router session, you are in user EXEC mode.

- User EXEC
- Privileged EXEC
- Global configuration

Table A-2 lists the command modes that are used in this guide, how to access each mode, the prompt you see in that mode, and how to exit to a mode or enter the next mode. Because each mode configures different router elements, you might need to enter and exit modes frequently. You can see a list of available commands for a particular mode by entering a question mark (?) at the prompt. For a description of each command, including syntax, see the Cisco IOS 12.3 documentation set.

Table A-2 Command Modes Summary

Mode	Access Method	Prompt	Exit and Entrance Method	About This Mode
User EXEC	Begin a session with your router.	`Router>`	To exit a router session, enter the **logout** command.	Use this mode for these tasks: • Change terminal settings. • Perform basic tests. • Display system information.
Privileged EXEC	Enter the **enable** command from user EXEC mode.	`Router#`	• To exit to user EXEC mode, enter the **disable** command. • To enter global configuration mode, enter the **configure** command.	Use this mode for these tasks: • Configure your router operating parameters. • Perform the verification steps shown in this guide. To prevent unauthorized changes to your router configuration, access to this mode should be protected with a password as described in "Enable Secret Passwords and Enable Passwords" later in this chapter.
Global configuration	Enter the **configure** command from privileged EXEC mode.	`Router (config)#`	• To exit to privileged EXEC mode, enter the **exit** or **end** command, or press **Ctrl-Z**. • To enter interface configuration mode, enter the **interface** command.	Use this mode to configure parameters that apply to your router as a whole. Also, you can access the following modes, which are described later in this table: • Interface configuration • Router configuration • Line configuration
Interface configuration	Enter the **interface** command (with a specific interface, such as **interface atm 0**) from global configuration mode.	`Router (config-if)#`	• To exit to global configuration mode, enter the **exit** command. • To exit to privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**. • To enter subinterface configuration mode, specify a subinterface with the **interface** command.	Use this mode to configure parameters for the router Ethernet and serial interfaces or subinterfaces.

Table A-2 Command Modes Summary (continued)

Mode	Access Method	Prompt	Exit and Entrance Method	About This Mode
Router configuration	Enter one of the **router** commands followed by the appropriate keyword, for example **router rip**, from global configuration mode.	`Router (config-router)#`	• To exit to global configuration mode, enter the **exit** command. • To exit to privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**.	Use this mode to configure an IP routing protocol.
Line configuration	Enter the **line** command with the desired line number, for example, **line 0**, from global configuration mode.	`Router (config-line)#`	• To exit to global configuration mode, enter the **exit** command. • To exit to privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**.	Use this mode to configure parameters for the terminal line.

Getting Help

You can use the question mark (?) and arrow keys to help you enter commands.

For a list of available commands at that command mode, enter a question mark:

```
Router> ?
access-enable  Create a temporary access-list entry
access-profile Apply user-profile to interface
clear          Reset functions
...
```

To complete a command, enter a few known characters followed by a question mark (with no space):

```
Router> s?
* s=show set show slip systat
```

For a list of command variables, enter the command followed by a space and a question mark:

```
Router> show ?
...
clock      Display the system clock
dialer     Dialer parameters and statistics
exception  exception information
...
```

To redisplay a command you previously entered, press the **Up Arrow** key. You can continue to press the Up Arrow key for more commands.

Enable Secret Passwords and Enable Passwords

By default, the router ships without password protection. Because many privileged EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use.

You can use two commands to do this:

- **enable secret** *password*—A very secure, encrypted password
- **enable** *password*—A less secure, unencrypted local password

Both the **enable** and **enable secret** passwords control access to various privilege levels (0 to 15). The **enable** password is intended for local use and is thus unencrypted. The **enable secret** password is intended for network use; that is, in environments where the password crosses the network or is stored on a TFTP server. You must enter an **enable secret** or **enable** password with a privilege level of 1 to gain access to privileged EXEC mode commands.

For maximum security, the passwords should be different. If you enter the same password for both during the setup process, your router accepts the passwords, but warns you that they should be different.

An **enable secret** password can contain from 1 to 25 uppercase and lowercase alphanumeric characters. An **enable** password can contain any number of uppercase and lowercase alphanumeric characters. In both cases, a number cannot be the first character. Spaces are also valid password characters; for example, *two words* is a valid password. Leading spaces are ignored; trailing spaces are recognized.

Entering Global Configuration Mode

To make any configuration changes to your router, you must be in global configuration mode. This section describes how to enter global configuration mode while using a terminal or PC that is connected to your router console port.

To enter global configuration mode, follow these steps:

Step 1 After your router boots up, enter the **enable** or **enable secret** command:

```
Router> enable
```

Step 2 If you have configured your router with an enable password, enter it when you are prompted.

The enable password does not appear on the screen when you enter it. This example shows how to enter privileged EXEC mode:

```
Password: enable_password
Router#
```

Privileged EXEC mode is indicated by the # in the prompt. You can now make changes to your router configuration.

Step 3 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
Router(config)#
```

You can now make changes to your router configuration.

Using Commands

This section provides some tips about entering Cisco IOS commands at the command-line interface (CLI).

Abbreviating Commands

You only have to enter enough characters for the router to recognize the command as unique. This example shows how to enter the **show version** command:

```
Router # sh v
```

Undoing Commands

If you want to disable a feature or undo a command you entered, you can enter the keyword **no** before most commands; for example, **no ip routing**.

Command-Line Error Messages

Table A-3 lists some error messages that you might encounter while using the CLI to configure your router.

Table A-3 Common CLI Error Messages

Error Message	Meaning	How to Get Help
`% Ambiguous command: "show con"`	You did not enter enough characters for your router to recognize the command.	Reenter the command, followed by a question mark (**?**) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Incomplete command.`	You did not enter all of the keywords or values required by this command.	Reenter the command, followed by a question mark (**?**) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Invalid input detected at '^' marker.`	You entered the command incorrectly. The error occurred where the caret mark (^) appears.	Enter a question mark (**?**) to display all of the commands that are available in this command mode.

Saving Configuration Changes

You need to enter the **copy running-config startup-config** command to save your configuration changes to nonvolatile RAM (NVRAM) so that they are not lost if there is a system reload or power outage. This example shows how to use this command to save your changes:

```
router# copy running-config startup-config
Destination filename [startup-config]?
```

Press **Return** to accept the default destination filename *startup-config*, or enter your desired destination filename and press **Return**.

It might take a minute or two to save the configuration to NVRAM. After the configuration has been saved, the following message appears:

```
Building configuration...
router#
```

Summary

Now that you have reviewed some Cisco IOS software basics, you can begin to configure your router. Remember:

- You can use the question mark (**?**) and arrow keys to help you enter commands.
- Each command mode restricts you to a set of commands. If you are having difficulty entering a command, check the prompt, and then enter the question mark (**?**) for a list of available commands. You might be in the wrong command mode or using the wrong syntax.
- If you want to disable a feature, enter the keyword **no** before the command; for example, **no ip routing**.
- Save your configuration changes to NVRAM so that they are not lost if there is a system reload or power outage.

Where to Go Next

To configure your router, go to Chapter 1, “Basic Router Configuration,” and Chapter 2, “Sample Network Deployments.”

Concepts

This appendix contains conceptual information that may be useful to Internet service providers or network administrators when they configure Cisco routers. To review some typical network scenarios, see Chapter 2, "Sample Network Deployments." For information on additional details or configuration topics, see Chapter 11, "Additional Configuration Options."

The following topics are included in this appendix:

- ADSL
- SHDSL
- Network Protocols
- Routing Protocol Options
- PPP Authentication Protocols
- TACACS+
- Network Interfaces
- Dial Backup
- NAT
- Easy IP (Phase 1)
- Easy IP (Phase 2)
- QoS
- Access Lists

ADSL

ADSL is a technology that allows both data and voice to be transmitted over the same line. It is a packet-based network technology that allows high-speed transmission over twisted-pair copper wire on the local loop ("last mile") between a network service provider (NSP) central office and the customer site, or on local loops created within either a building or a campus.

The benefit of ADSL over a serial or dialup line is that it is always on and always connected, increasing bandwidth and lowering the costs compared with a dialup or leased line. ADSL technology is asymmetric in that it allows more bandwidth from an NSP central office to the customer site than from the customer site to the central office. This asymmetry, combined with always-on access (which eliminates call setup), makes ADSL ideal for Internet and intranet surfing, video on demand, and remote LAN access.

SHDSL

SHDSL is a technology based on the G.SHDSL (G.991.2) standard that allows both data and voice to be transmitted over the same line. SHDSL is a packet-based network technology that allows high-speed transmission over twisted-pair copper wire between a network service provider (NSP) central office and a customer site, or on local loops created within either a building or a campus.

G.SHDSL devices can extend the reach from central offices and remote terminals to approximately 26,000 feet (7925 m), at symmetrical data rates from 72 kbps up to 2.3 Mbps. In addition, it is repeatable at lower speeds, which means there is virtually no limit to its reach.

SHDSL technology is symmetric in that it allows equal bandwidth between an NSP central office and a customer site. This symmetry, combined with always-on access (which eliminates call setup), makes SHDSL ideal for LAN access.

Network Protocols

Network protocols enable the network to pass data from its source to a specific destination over LAN or WAN links. Routing address tables are included in the network protocols to provide the best path for moving the data through the network.

IP

The best-known Transmission Control Protocol/Internet Protocol (TCP/IP) at the internetwork layer is IP, which provides the basic packet delivery service for all TCP/IP networks. In addition to the physical node addresses, the IP protocol implements a system of logical host addresses called IP addresses. The IP addresses are used by the internetwork and higher layers to identify devices and to perform internetwork routing. The Address Resolution Protocol (ARP) enables IP to identify the physical address that matches a given IP address.

IP is used by all protocols in the layers above and below it to deliver data, which means that all TCP/IP data flows through IP when it is sent and received regardless of its final destination.

IP is a connectionless protocol, which means that IP does not exchange control information (called a *handshake*) to establish an end-to-end connection before transmitting data. In contrast, a connection-oriented protocol exchanges control information with the remote computer to verify that it is ready to receive data before sending it. When the handshaking is successful, the computers have established a connection. IP relies on protocols in other layers to establish the connection if connection-oriented services are required.

Internet Packet Exchange (IPX) exchanges routing information using Routing Information Protocol (RIP), a dynamic distance-vector routing protocol. RIP is described in more detail in the following subsections.

Routing Protocol Options

Routing protocols include the following:

- Routing Information Protocol (RIP)
- Enhanced Interior Gateway Routing Protocol (Enhanced IGRP)

RIP and Enhanced IGRP differ in several ways, as shown in Table B-1.

Table B-1 RIP and Enhanced IGRP Comparison

Protocol	Ideal Topology	Metric	Routing Updates
RIP	Suited for topologies with 15 or fewer hops.	Hop count. Maximum hop count is 15. Best route is one with lowest hop count.	By default, every 30 seconds. You can reconfigure this value and also use triggered extensions to RIP.
Enhanced IGRP	Suited for large topologies with 16 or more hops to reach a destination.	Distance information. Based on a successor, which is a neighboring router that has a least-cost path to a destination that is guaranteed to not be part of a routing loop.	Hello packets sent every 5 seconds, as well as incremental updates sent when the state of a destination changes.

RIP

RIP is an associated protocol for IP, and is widely used for routing protocol traffic over the Internet. RIP is a distance-vector routing protocol, which means that it uses distance (hop count) as its metric for route selection. *Hop count* is the number of routers that a packet must traverse to reach its destination. For example, if a particular route has a hop count of 2, then a packet must traverse two routers to reach its destination.

By default, RIP routing updates are broadcast every 30 seconds. You can reconfigure the interval at which the routing updates are broadcast. You can also configure triggered extensions to RIP so that routing updates are sent only when the routing database is updated. For more information on triggered extensions to RIP, see the Cisco IOS Release 12.3 documentation set.

Enhanced IGRP

Enhanced IGRP is an advanced Cisco proprietary distance-vector and link state routing protocol, which means it uses a metric more sophisticated than distance (hop count) for route selection. Enhanced IGRP uses a metric based on a successor, which is a neighboring router that has a least-cost path to a destination that is guaranteed not to be part of a routing loop. If a successor for a particular destination does not exist but neighbors advertise the destination, the router must recompute a route.

Each router running Enhanced IGRP sends hello packets every 5 seconds to inform neighboring routers that it is functioning. If a particular router does not send a hello packet within a prescribed period, Enhanced IGRP assumes that the state of a destination has changed and sends an incremental update.

Because Enhanced IGRP supports IP, you can use one routing protocol for multiprotocol network environments, minimizing the size of the routing tables and the amount of routing information.

PPP Authentication Protocols

The Point-to-Point Protocol (PPP) encapsulates network layer protocol information over point-to-point links. PPP originally emerged as an encapsulation protocol for transporting IP traffic over point-to-point links. PPP also established a standard for the assignment and management of IP addresses, asynchronous

(start/stop) and bit-oriented synchronous encapsulation, network protocol multiplexing, link configuration, link quality testing, error detection, and option negotiation for such capabilities as network-layer address negotiation and data-compression negotiation. PPP supports these functions by providing an extensible Link Control Protocol (LCP) and a family of Network Control Protocols (NCPs) to negotiate optional configuration parameters and facilities.

The current implementation of PPP supports two security authentication protocols to authenticate a PPP session:

- Password Authentication Protocol (PAP)
- Challenge Handshake Authentication Protocol (CHAP)

PPP with PAP or CHAP authentication is often used to inform the central site which remote routers are connected to it.

PAP

PAP uses a two-way handshake to verify the passwords between routers. To illustrate how PAP works, imagine a network topology in which a remote office Cisco router is connected to a corporate office Cisco router. After the PPP link is established, the remote office router repeatedly sends a configured username and password until the corporate office router accepts the authentication.

PAP has the following characteristics:

- The password portion of the authentication is sent across the link in clear text (not scrambled or encrypted).
- PAP provides no protection from playback or repeated trial-and-error attacks.
- The remote office router controls the frequency and timing of the authentication attempts.

CHAP

CHAP uses a three-way handshake to verify passwords. To illustrate how CHAP works, imagine a network topology in which a remote office Cisco router is connected to a corporate office Cisco router.

After the PPP link is established, the corporate office router sends a challenge message to the remote office router. The remote office router responds with a variable value. The corporate office router checks the response against its own calculation of the value. If the values match, the corporate office router accepts the authentication. The authentication process can be repeated any time after the link is established.

CHAP has the following characteristics:

- The authentication process uses a variable challenge value rather than a password.
- CHAP protects against playback attack through the use of the variable challenge value, which is unique and unpredictable. Repeated challenges limit the time of exposure to any single attack.
- The corporate office router controls the frequency and timing of the authentication attempts.

Note We recommend using CHAP because it is the more secure of the two protocols.

TACACS+

Cisco 1800 fixed-configuration routers support the Terminal Access Controller Access Control System Plus (TACACS+) protocol through Telnet. TACACS+ is a Cisco proprietary authentication protocol that provides remote access authentication and related network security services, such as event logging. User passwords are administered in a central database rather than in individual routers. TACACS+ also provides support for separate modular authentication, authorization, and accounting (AAA) facilities that are configured at individual routers.

Network Interfaces

This section describes the network interface protocols that Cisco 1800 fixed-configuration routers support. The following network interface protocols are supported:

- Ethernet
- ATM

Ethernet

Ethernet is a baseband LAN protocol that transports data and voice packets to the WAN interface using carrier sense multiple access collision detect (CSMA/CD). The term is now often used to refer to all CSMA/CD LANs. Ethernet was designed to serve in networks with sporadic, occasionally heavy traffic requirements, and the IEEE 802.3 specification was developed in 1980 based on the original Ethernet technology.

Under the Ethernet CSMA/CD media-access process, any host on a CSMA/CD LAN can access the network at any time. Before sending data, CSMA/CD hosts listen for traffic on the network. A host wanting to send data waits until it detects no traffic before it transmits. Ethernet allows any host on the network to transmit whenever the network is quiet. A collision occurs when two hosts listen for traffic, hear none, and then transmit simultaneously. In this situation, both transmissions are damaged, and the hosts must retransmit at some later time. Algorithms determine when the colliding hosts should retransmit.

ATM

Asynchronous Transfer Mode (ATM) is a high-speed multiplexing and switching protocol that supports multiple traffic types, including voice, data, video, and imaging.

ATM is composed of fixed-length cells that switch and multiplex all information for the network. An ATM connection is simply used to transfer bits of information to a destination router or host. The ATM network is considered a LAN with high bandwidth availability. Unlike a LAN, which is connectionless, ATM requires certain features to provide a LAN environment to the users.

Each ATM node must establish a separate connection to every node in the ATM network that it needs to communicate with. All such connections are established through a permanent virtual circuit (PVC).

PVC

A PVC is a connection between remote hosts and routers. A PVC is established for each ATM end node with which the router communicates. The characteristics of the PVC that are established when it is created are set by the ATM adaptation layer (AAL) and the encapsulation type. An AAL defines the conversion of user information into cells. An AAL segments upper-layer information into cells at the transmitter and reassembles the cells at the receiver.

Cisco routers support the AAL5 format, which provides a streamlined data transport service that functions with less overhead and affords better error detection and correction capabilities than AAL3/4. AAL5 is typically associated with variable bit rate (VBR) traffic and unspecified bit rate (UBR) traffic. Cisco 1800 series routers also support AAL1 and 2 formats.

ATM encapsulation is the wrapping of data in a particular protocol header. The type of router to which you are connecting determines the type of ATM PVC encapsulation types.

The routers support the following encapsulation types for ATM PVCs:

- LLC/SNAP (RFC 1483)
- VC-MUX (RFC 1483)
- PPP (RFC 2364)

Each PVC is considered a complete and separate link to a destination node. Users can encapsulate data as needed across the connection. The ATM network disregards the contents of the data. The only requirement is that data be sent to the ATM subsystem of the router in a manner that follows the specific AAL format.

Dialer Interface

A dialer interface assigns PPP features (such as authentication and IP address assignment method) to a PVC. Dialer interfaces are used when configuring PPP over ATM.

Dialer interfaces can be configured independently of any physical interface and applied dynamically as needed.

Dial Backup

Dial backup provides protection against WAN downtime by allowing a user to configure a backup modem line connection. The following can be used to bring up the dial backup feature in Cisco IOS software:

- Backup Interface
- Floating Static Routes
- Dialer Watch

Backup Interface

A backup interface is an interface that stays idle until certain circumstances occur, such as WAN downtime, at which point it is activated. The backup interface can be a physical interface such as a Basic Rate Interface (BRI), or an assigned backup dialer interface to be used in a dialer pool. While the primary

line is up, the backup interface is placed in standby mode. In standby mode, the backup interface is effectively shut down until it is enabled. Any route associated with the backup interface does not appear in the routing table.

Because the backup interface command is dependent on the router's identifying that an interface is physically down, it is commonly used to back up ISDN BRI connections, asynchronous lines, and leased lines. The interfaces to such connections go down when the primary line fails, and the backup interface quickly identifies such failures.

Floating Static Routes

Floating static routes are static routes that have an administrative distance greater than the administrative distance of dynamic routes. Administrative distances can be configured on a static route so that the static route is less desirable than a dynamic route. In this manner, the static route is not used when the dynamic route is available. However, if the dynamic route is lost, the static route can take over, and the traffic can be sent through this alternative route. If this alternative route uses a dial-on-demand routing (DDR) interface, then that interface can be used as a backup feature.

Dialer Watch

Dialer watch is a backup feature that integrates dial backup with routing capabilities. Dialer watch provides reliable connectivity without having to define traffic of interest to trigger outgoing calls at the central router. Hence, dialer watch can be considered regular DDR with no requirement for traffic of interest. By configuring a set of watched routes that define the primary interface, you are able to monitor and track the status of the primary interface as watched routes are added and deleted.

When a watched route is deleted, dialer watch checks for at least one valid route for any of the IP addresses or networks being watched. If there is no valid route, the primary line is considered down and unusable. If there is a valid route for at least one of the watched IP networks defined and the route is pointing to an interface other than the backup interface configured for dialer watch, the primary link is considered up and dialer watch does not initiate the backup link.

NAT

Network Address Translation (NAT) provides a mechanism for a privately addressed network to access registered networks, such as the Internet, without requiring a registered subnet address. This mechanism eliminates the need for host renumbering and allows the same IP address range to be used in multiple intranets.

NAT is configured on the router at the border of an *inside network* (a network that uses nonregistered IP addresses) and an *outside network* (a network that uses a globally unique IP address; in this case, the Internet). NAT translates the inside local addresses (the nonregistered IP addresses assigned to hosts on the inside network) into globally unique IP addresses before sending packets to the outside network.

With NAT, the inside network continues to use its existing private or obsolete addresses. These addresses are converted into legal addresses before packets are forwarded onto the outside network. The translation function is compatible with standard routing; the feature is required only on the router connecting the inside network to the outside domain.

Translations can be static or dynamic. A static address translation establishes a one-to-one mapping between the inside network and the outside domain. Dynamic address translations are defined by describing the local addresses to be translated and the pool of addresses from which to allocate outside addresses. Allocation occurs in numeric order, and multiple pools of contiguous address blocks can be defined.

NAT eliminates the need to readdress all hosts that require external access, saving time and money. It also conserves addresses through application port-level multiplexing. With NAT, internal hosts can share a single registered IP address for all external communications. In this type of configuration, relatively few external addresses are required to support many internal hosts, thus conserving IP addresses.

Because the addressing scheme on the inside network may conflict with registered addresses already assigned within the Internet, NAT can support a separate address pool for overlapping networks and translate as appropriate.

Easy IP (Phase 1)

The Easy IP (Phase 1) feature combines Network Address Translation (NAT) and PPP/Internet Protocol Control Protocol (IPCP). This feature enables a Cisco router to automatically negotiate its own registered WAN interface IP address from a central server and to enable all remote hosts to access the Internet using this single registered IP address. Because Easy IP (Phase 1) uses existing port-level multiplexed NAT functionality within Cisco IOS software, IP addresses on the remote LAN are invisible to the Internet.

The Easy IP (Phase 1) feature combines NAT and PPP/IPCP. With NAT, the router translates the nonregistered IP addresses used by the LAN devices into the globally unique IP address used by the dialer interface. The ability of multiple LAN devices to use the same globally unique IP address is known as *overloading*. NAT is configured on the router at the border of an inside network (a network that uses nonregistered IP addresses) and an outside network (a network that uses a globally unique IP address; in this case, the Internet).

With PPP/IPCP, Cisco routers automatically negotiate a globally unique (registered) IP address for the dialer interface from the ISP router.

Easy IP (Phase 2)

The Easy IP (Phase 2) feature combines Dynamic Host Configuration Protocol (DHCP) server and relay. DHCP is a client-server protocol that enables devices on an IP network (the DHCP clients) to request configuration information from a DHCP server. DHCP allocates network addresses from a central pool on an as-needed basis. DHCP is useful for assigning IP addresses to hosts connected to the network temporarily or for sharing a limited pool of IP addresses among a group of hosts that do not need permanent IP addresses.

DHCP frees you from having to assign an IP address to each client manually.

DHCP configures the router to forward UDP broadcasts, including IP address requests, from DHCP clients. DHCP allows for increased automation and fewer network administration problems by:

- Eliminating the need for the manual configuration of individual computers, printers, and shared file systems
- Preventing the simultaneous use of the same IP address by two clients
- Allowing configuration from a central site

QoS

This section describes Quality of Service (QoS) parameters, including the following:

- IP Precedence
- PPP Fragmentation and Interleaving
- CBWFQ
- RSVP
- Low Latency Queuing

QoS refers to the capability of a network to provide better service to selected network traffic over various technologies, including ATM, Ethernet and IEEE 802.1 networks, and IP-routed networks that may use any or all of these underlying technologies. Primary goals of QoS include dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics. QoS technologies provide the elemental building blocks for future business applications in campus, WAN, and service provider networks.

QoS must be configured throughout your network, not just on your router running VoIP, to improve voice network performance. Not all QoS techniques are appropriate for all network routers. Edge routers and backbone routers in your network do not necessarily perform the same operations; the QoS tasks they perform might differ as well. To configure your IP network for real-time voice traffic, you need to consider the functions of both edge and backbone routers in your network.

QoS software enables complex networks to control and predictably service a variety of networked applications and traffic types. Almost any network can take advantage of QoS for optimum efficiency, whether it is a small corporate network, an Internet service provider, or an enterprise network.

IP Precedence

You can partition traffic in up to six classes of service using IP Precedence (two others are reserved for internal network use). The queuing technologies throughout the network can then use this signal to expedite handling.

Features such as policy-based routing and committed access rate (CAR) can be used to set precedence based on extended access-list classification. This allows considerable flexibility for precedence assignment, including assignment by application or user, by destination and source subnet, and so on. Typically this functionality is deployed as close to the edge of the network (or administrative domain) as possible, so that each subsequent network element can provide service based on the determined policy.

IP Precedence can also be set in the host or network client with the signaling used optionally. IP Precedence enables service classes to be established using existing network queuing mechanisms (such as class-based weighted fair queuing [CBWFQ]), with no changes to existing applications or complicated network requirements.

PPP Fragmentation and Interleaving

With multiclass multilink PPP interleaving, large packets can be multilink-encapsulated and fragmented into smaller packets to satisfy the delay requirements of real-time voice traffic; small real-time packets, which are not multilink encapsulated, are transmitted between fragments of the large packets. The interleaving feature also provides a special transmit queue for the smaller, delay-sensitive packets, enabling them to be transmitted earlier than other flows. Interleaving provides the delay bounds for delay-sensitive voice packets on a slow link that is used for other best-effort traffic.

In general, multilink PPP with interleaving is used in conjunction with CBWFQ and RSVP or IP Precedence to ensure voice packet delivery. Use multilink PPP with interleaving and CBWFQ to define how data is managed; use Resource Reservation Protocol (RSVP) or IP Precedence to give priority to voice packets.

CBWFQ

In general, class-based weighted fair queuing (CBWFQ) is used in conjunction with multilink PPP and interleaving and RSVP or IP Precedence to ensure voice packet delivery. CBWFQ is used with multilink PPP to define how data is managed; RSVP or IP Precedence is used to give priority to voice packets.

There are two levels of queueing; ATM queues and Cisco IOS queues. CBWFQ is applied to Cisco IOS queues. A first-in-first-out (FIFO) Cisco IOS queue is automatically created when a PVC is created. If you use CBWFQ to create classes and attach them to a PVC, a queue is created for each class.

CBWFQ ensures that queues have sufficient bandwidth and that traffic gets predictable service. Low-volume traffic streams are preferred; high-volume traffic streams share the remaining capacity, obtaining equal or proportional bandwidth.

RSVP

RSVP enables routers to reserve enough bandwidth on an interface to ensure reliability and quality performance. RSVP allows end systems to request a particular QoS from the network. Real-time voice traffic requires network consistency. Without consistent QoS, real-time traffic can experience jitter, insufficient bandwidth, delay variations, or information loss. RSVP works in conjunction with current queuing mechanisms. It is up to the interface queuing mechanism (such as CBWFQ) to implement the reservation.

RSVP works well on PPP, HDLC, and similar serial-line interfaces. It does not work well on multi-access LANs. RSVP can be equated to a dynamic access list for packet flows.

You should configure RSVP to ensure QoS if the following conditions describe your network:

- Small-scale voice network implementation
- Links slower than 2 Mbps
- Links with high utilization
- Need for the best possible voice quality

Low Latency Queuing

Low latency queuing (LLQ) provides a low-latency strict priority transmit queue for real-time traffic. Strict priority queuing allows delay-sensitive data to be dequeued and sent first (before packets in other queues are dequeued), giving delay-sensitive data preferential treatment over other traffic.

Access Lists

With basic standard and static extended access lists, you can approximate session filtering by using the established keyword with the **permit** command. The established keyword filters TCP packets based on whether the ACK or RST bits are set. (Set ACK or RST bits indicate that the packet is not the first in the session and the packet therefore belongs to an established session.) This filter criterion would be part of an access list applied permanently to an interface.

ROM Monitor

The ROM monitor firmware runs when the router is powered up or reset. The firmware helps to initialize the processor hardware and boot the operating system software. You can use the ROM monitor to perform certain configuration tasks, such as recovering a lost password or downloading software over the console port. If there is no Cisco IOS software image loaded on the router, the ROM monitor runs the router.

This appendix contains the following sections:

Entering the ROM Monitor

To use the ROM monitor, you must be using a terminal or PC that is connected to the router over the console port.

Perform these steps to configure the router to boot up in ROM monitor mode the next time it is rebooted.

	Command	Purpose
Step 1	**enable**	Enters privileged EXEC mode. If an enable password is configured, you must enter the enable command and the enable password to enter privileged EXEC mode.
Step 2	**configure terminal**	Enters global configuration mode.
Step 3	**config-reg 0x0**	Resets the configuration register.

	Command	Purpose
Step 4	**exit**	Exits global configuration mode.
Step 5	**reload**	Reboots the router with the new configuration register value. The router remains in ROM monitor and does not boot the Cisco IOS software. As long as the configuration value is 0x0, you must manually boot the operating system from the console. See the **boot** command in the "Command Descriptions" section in this appendix. After the router reboots, it is in ROM monitor mode. The number in the prompt increments with each new line.

Timesaver Break (system interrupt) is always enabled for 60 seconds after the router reboots, regardless of whether it is set to on or off in the configuration register. During this 60-second window, you can break to the ROM monitor prompt by pressing the Break key.

ROM Monitor Commands

Enter **?** or **help** at the ROM monitor prompt to display a list of available commands and options, as follows:

```
rommon 1 > ?
alias              set and display aliases command
boot               boot up an external process
break              set/show/clear the breakpoint
confreg            configuration register utility
cont               continue executing a downloaded image
context            display the context of a loaded image
cookie             display contents of cookie PROM in hex
dir                List files in directories-dir <directory>
dis                display instruction stream
format             Format a filesystem-format <filessystem>
frame              print out a selected stack frame
fsck               Check filesystem consistency-fsck <filesystem>
help               monitor builtin command help
history            monitor command history
meminfo            main memory information
more               Concatenate (type) file(s)-cat <filenames ...>
repeat             repeat a monitor command
reset              system reset
set                display the monitor variables
stack              produce a stack trace
sync               write monitor environment to NVRAM
sysret             print out info from last system return
tftpdnld           tftp image download
unalias            unset an alias
unset              unset a monitor variable
xmodem             x/ymodem image download
```

Commands are case sensitive. You can halt any command by pressing the Break key on a terminal. If you are using a PC, most terminal emulation programs halt a command when you press the Ctrl and the Break keys at the same time. If you are using another type of terminal emulator or terminal emulation software, see the documentation for that product for information on how to send a Break command.

Command Descriptions

Table C-1 describes the most commonly used ROM monitor commands.

Table C-1 Commonly Used ROM Monitor Commands

Command	Description
help or **?**	Displays a summary of all available ROM monitor commands.

-?	Displays information about command syntax; for example:
	`rommon 16 > dis -?`
	`usage : dis [addr] [length]`
	The output for this command is slightly different for the **xmodem** download command:
	`rommon 11 > xmodem -?`
	`xmodem: illegal option -- ?`
	`usage: xmodem [-cyrxu] <destination filename>`
	`-c  CRC-16`
	`-y  ymodem-batch protocol`
	`-r  copy image to dram for launch`
	`-x  do not launch on download completion`
	`-u  upgrade ROMMON, System will reboot after upgrade`

reset or **i**	Resets and initializes the router, similar to a power up.

dir *device***:**	Lists the files on the named device; for example, flash memory files:
	`rommon 4 > dir flash:`
	`Directory of flash:/`
	`2 -rwx 10283208 <date> c1800-advsecurityk9-mz`
	`9064448 bytes available (10289152 bytes used)`

boot commands	For more information about the ROM monitor boot commands, see the *Cisco IOS Configuration Fundamentals and Network Management Guide*.
b	Boots the first image in flash memory.
b flash: [*filename*]	Attempts to boot the image directly from the first partition of flash memory. If you do not enter a filename, this command will boot this first image in flash memory.

Disaster Recovery with TFTP Download

The standard way to load new software on your router is to use the **copy tftp flash** privileged EXEC command from the Cisco IOS software command-line interface (CLI). However, if the router is unable to boot Cisco IOS software, you can load new software while in ROM monitor mode.

This section describes how to load a Cisco IOS software image from a remote TFTP server to the router flash memory. Use the **tftpdnld** command only for disaster recovery, because it erases all existing data in flash memory before downloading a new software image to the router.

TFTP Download Command Variables

This section describes the system variables that can be set in ROM monitor mode and that are used during the TFTP download process. There are both required variables and optional variables.

Note The commands described in this section are case sensitive and must be entered exactly as shown.

Required Variables

These variables must be set with these commands before you use the **tftpdnld** command:

Variable	Command
IP address of the router.	**IP_ADDRESS=** *ip_address*
Subnet mask of the router.	**IP_SUBNET_MASK=** *ip_address*
IP address of the default gateway of the router.	**DEFAULT_GATEWAY=** *ip_address*
Port number of the Fast Ethernet port used to connect to the network.	**FE_PORT=***fe_port_number*
IP address of the TFTP server from which the software will be downloaded.	**TFTP_SERVER=** *ip_address*
Name of the file that will be downloaded to the router.	**TFTP_FILE=** *filename*

Optional Variables

These variables can be set with these commands before you use the **tftpdnld** command:

Variable	Command
Configures how the router displays file download progress. 0—No progress is displayed. 1—Exclamation points (!!!) are displayed to indicate file download progress. This is the default setting. 2—Detailed progress is displayed during the file download process; for example: • Initializing interface. • Interface link state up. • ARPing for 1.4.0.1 • ARP reply for 1.4.0.1 received. MAC address 00:00:0c:07:ac:01	**TFTP_VERBOSE=** *setting*

Number of times the router attempts ARP and TFTP download. The default is 7.	**TFTP_RETRY_COUNT=** *retry_times*
Length of time, in seconds, before the download process times out. The default is 2,400 seconds (40 minutes).	**TFTP_TIMEOUT=** *time*
Whether or not the router performs a checksum test on the downloaded image: 1—Checksum test is performed. 0—No checksum test is performed.	**TFTP_CHECKSUM=***setting*

Using the TFTP Download Command

Perform these steps in ROM monitor mode to download a file through TFTP.

Step 1 Use the appropriate commands to enter all the required variables and any optional variables described in preceding sections.

Step 2 Enter the **tftpdnld** command as follows:

```
rommon 1 > tftpdnld -r
```

Note The **-r** variable is optional. Entering this variable downloads and boots the new software but does not save the software to flash memory. You can then use the image that is in flash memory the next time you enter the **reload** command.

You will see output similar to the following:

```
IP_ADDRESS: 10.3.6.7
IP_SUBNET_MASK: 255.255.0.0
DEFAULT_GATEWAY: 10.3.0.1
TFTP_SERVER: 223.255.254.254
TFTP_FILE: c1800-advsecurityk9-mz
Do you wish to continue? y/n:  [n]:
```

Step 3 If you are sure that you want to continue, enter **y** in response to the question in the output:

```
Do you wish to continue? y/n:  [n]:y
```

The router begins to download the new file.

If you mistakenly entered yes, you can enter **Ctrl-C** or **Break** to stop the transfer before the flash memory is erased.

Configuration Register

The virtual configuration register is in nonvolatile RAM (NVRAM) and has the same functionality as other Cisco routers. You can view or modify the virtual configuration register from either the ROM monitor or the operating system software. Within the ROM monitor, you can change the configuration register by entering the register value in hexadecimal format, or by allowing the ROM monitor to prompt you for the setting of each bit.

Changing the Configuration Register Manually

To change the virtual configuration register from the ROM monitor manually, enter the **confreg** command, followed by the new value of the register in hexadecimal format, as shown in the following example:

```
rommon 1 > confreg 0x2101


You must reset or power cycle for new config to take effect
rommon 2 >
```

The value is always interpreted as hexadecimal. The new virtual configuration register value is written into NVRAM but does not take effect until you reset or reboot the router.

Changing the Configuration Register Using Prompts

Entering the **confreg** command without an argument displays the contents of the virtual configuration register and a prompt to alter the contents by describing the meaning of each bit.

In either case, the new virtual configuration register value is written into NVRAM but does not take effect until you reset or reboot the router.

The following display shows an example of entering the **confreg** command:

```
rommon 7> confreg

     Configuration Summary
enabled are:
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:  y
enable  "diagnostic mode"? y/n  [n]:  y
enable  "use net in IP bcast address"? y/n  [n]:
enable  "load rom after netboot fails"? y/n  [n]:
enable  "use all zero broadcast"? y/n  [n]:
enable  "break/abort has effect"? y/n  [n]:
enable  "ignore system config info"? y/n  [n]:
change console baud rate? y/n  [n]:  y
enter rate: 0 = 9600, 1 = 4800, 2 = 1200, 3 = 2400  [0]:  0
change the boot characteristics? y/n  [n]:  y
enter to boot:
 0 = ROM Monitor
 1 = the boot helper image
 2-15 = boot system
    [0]:  0

Configuration Summary
```

```
enabled are:
diagnostic mode
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:


You must reset or power cycle for new config to take effect
```

Console Download

You can use console download, a ROM monitor function, to download either a software image or a configuration file over the router console port. After download, the file is either saved to the CompactFlash memory module or to main memory for execution (image files only).

Use console download when you do not have access to a TFTP server.

Note If you are using a PC to download a Cisco IOS image over the router console port at 115,200 bps, ensure that the PC serial port is using a 16550 universal asynchronous transmitter/receiver (UART). If the PC serial port is not using a 16550 UART, we recommend using a speed of 38,400 bps or less when downloading a Cisco IOS image over the console port.

Command Description

The following are the syntax and descriptions for the **xmodem** console download command:

xmodem [-cyrx] *destination_file_name*

c	Optional. Performs the download using 16-bit cyclic redundancy check (CRC-16) error checking to validate packets. Default is 8-bit CRC.
y	Optional. Sets the router to perform the download using Ymodem protocol, the default is Xmodem protocol. The protocols differ as follows: • Xmodem supports a 128-block transfer size. Ymodem supports a 1024-block transfer size. • Ymodem uses CRC-16 error checking to validate each packet. Depending on the device that the software is being downloaded from, this function might not be supported by Xmodem.
r	Optional. Image is loaded into DRAM for execution. The default is to load the image into flash memory.
x	Optional. Image is loaded into DRAM without being executed.
destination_file_name	Name of the system image file or the system configuration file. In order for the router to recognize it, the name of the configuration file must be *router_confg*.

Follow these steps to run Xmodem:

Step 1 Move the image file to the local drive where Xmodem will execute.

Step 2 Enter the **xmodem** command.

Error Reporting

Because the ROM monitor console download uses the console to perform the data transfer, when an error occurs during a data transfer, error messages are only displayed on the console once the data transfer is terminated.

If you have changed the baud rate from the default rate, the error message is followed by a message telling you to restore the terminal to the baud rate specified in the configuration register.

Debug Commands

Most ROM monitor debugging commands are functional only when Cisco IOS software has crashed or is halted. If you enter a debugging command and Cisco IOS crash information is not available, you see the following error message:

```
"xxx: kernel context state is invalid, can not proceed."
```

The following are ROM monitor debugging commands:

- **stack** or **k**—Produces a stack trace; for example:

```
rommon 6> stack
Stack trace:
PC = 0x801111b0
Frame 00: FP = 0x80005ea8    PC = 0x801111b0
Frame 01: FP = 0x80005eb4    PC = 0x80113694
Frame 02: FP = 0x80005f74    PC = 0x8010eb44
Frame 03: FP = 0x80005f9c    PC = 0x80008118
Frame 04: FP = 0x80005fac    PC = 0x80008064
Frame 05: FP = 0x80005fc4    PC = 0xfff03d70
```

- **context**—Displays processor context; for example:

```
> context
xt of the most recent exception
000000 R1 = 0x832552c4 R2 = 0xffffffffR3 = 0x00000000
000021 R5 = 0x839960a8 R6 = 0x00029220R7 = 0xffffffff
9c0000 R9 = 0xffffffff R22 = 0xffffffff R23 = 0xffffffff
000e881 R13 = 0xffffffff R14 = 0xffffffff R15 = 0xffffffff
fffffff R25 = 0xffffffff R30 = 0xffffffff IVPR = 0xffffffff
fffffff R25 = 0xffffffff R26 = 0xffffffff R27 = 0xffffffff
fffffff R29 = 0xffffffff R30 = 0xffffffff R31 = 0xffffffff
888002 LR = 0x800e3638 CTR = 0x8003af88 XER = 0xffffffff
fffffff TBL = 0xffffffff DEAR = 0xffffffff DBCR2 = Oxffffffff
fffffff DBCR0 = 0xffffffff DBCR1 = 0xffffffff DBCR2 = 0xffffffff
ffffffff IAC2 = 0xffffffff DAC1 = 0xffffffff MCSRR1 = 0xffffffff
03af88 MSR = 0x00029220
```

- **frame**—Displays an individual stack frame.

- **sysret**—Displays return information from the last booted system image. This information includes the reason for terminating the image, a stack dump of up to eight frames, and, if an exception is involved, the address where the exception occurred; for example:

```
rommon 8> sysret
System Return Info:
count: 19,  reason: user break
pc:0x801111b0,  error address: 0x801111b0
Stack Trace:
FP: 0x80005ea8, PC: 0x801111b0
FP: 0x80005eb4, PC: 0x80113694
FP: 0x80005f74, PC: 0x8010eb44
FP: 0x80005f9c, PC: 0x80008118
FP: 0x80005fac, PC: 0x80008064
FP: 0x80005fc4, PC: 0xfff03d70
FP: 0x80005ffc, PC: 0x00000000
FP: 0x00000000, PC: 0x00000000
```

- **meminfo**—Displays size in bytes, starting address, available range of main memory, the starting point and size of packet memory, and size of NVRAM; for example:

```
rommon 9> meminfo
Main memory size: 256 MB.
Available main memory starts at 0x80012000, size 0x3ffb8 KB IO (packet) memory size:
10 percent of main memory.
NVRAM size: 192 KB
```

Exiting the ROM Monitor

You must set the configuration register to a value from 0x2 to 0xF for the router to boot a Cisco IOS image from flash memory upon startup or reloading.

The following example shows how to reset the configuration register and cause the router to boot a Cisco IOS image stored in flash memory:

```
rommon 1 > confreg 0x2101
```

You must reset or power cycle for new configuration register to take effect:

```
rommon 2 > boot
```

The router will boot the Cisco IOS image in flash memory. The configuration register will change to 0x2101 the next time the router is reset or power cycled.

Common Port Assignments

Table D-1 lists currently assigned Transmission Control Protocol (TCP) port numbers. To the extent possible, the User Datagram Protocol (UDP) uses the same numbers.

Table D-1 Currently Assigned TCP and UDP Port Numbers

Port	Keyword	Description
0	—	Reserved
1–4	—	Unassigned
5	RJE	Remote job entry
7	ECHO	Echo
9	DISCARD	Discard
11	USERS	Active users
13	DAYTIME	Daytime
15	NETSTAT	Netstat
17	QUOTE	Quote of the day
19	CHARGEN	Character generator
20	FTP-DATA	File Transfer Protocol (data)
21	FTP	File Transfer Protocol
23	TELNET	Terminal connection
25	SMTP	Simple Mail Transport Protocol
37	TIME	Time
39	RLP	Resource Location Protocol
42	NAMESERVER	Hostname server
43	NICNAME	Who is
49	LOGIN	Login Host Protocol
53	DOMAIN	Domain name server
67	BOOTPS	Bootstrap Protocol Server
68	BOOTPC	Bootstrap Protocol Client
69	TFTP	Trivial File Transfer Protocol
75	–	Any private dial-out service

Table D-1 Currently Assigned TCP and UDP Port Numbers (continued)

Port	Keyword	Description
77	–	Any private RJE service
79	FINGER	Finger
95	SUPDUP	SUPDUP Protocol
101	HOST NAME	Network interface card (NIC) hostname server
102	ISO-TSAP	ISO-Transport Service Access Point (TSAP)
103	X400	X400
104	X400-SND	X400-SND
111	SUNRPC	Sun Microsystems Remote Procedure Call
113	AUTH	Authentication service
117	UUCP-PATH	UNIX-to-UNIX Copy Protocol (UUCP) Path Service
119	NNTP	Usenet Network News Transfer Protocol
123	NTP	Network Time Protocol
126	SNMP	Simple Network Management Protocol
137	NETBIOS-NS	NetBIOS name service
138	NETBIOS-DGM	NetBIOS datagram service
139	NETBIOS-SSN	NetBIOS session service
161	SNMP	Simple Network Management Protocol
162	SNMP-TRAP	Simple Network Management Protocol traps
512	rexec	UNIX remote execution (control)
513	TCP—rlogin UDP—rwho	TCP—UNIX remote login UDP—UNIX broadcast name service
514	TCP—rsh UDP—syslog	TCP—UNIX remote shell UDP—system log
515	Printer	UNIX line printer remote spooling
520	RIP	Routing Information Protocol
525	Timed	Time server

Symbols

Numerics

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

Q

R

S

T

U

V

W

X