Cisco 819 Series Integrated Services Routers Software Configuration Guide

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

Text Part Number: OL-23590-02
September 2, 2013

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CHAPTER 1

Product Overview

This chapter provides an overview of the features available for the Cisco 819 Integrated Services Routers (ISRs) and contains the following sections:

- General Description, page 1-1
- SKU Information, page 1-3
- New Features, page 1-3

General Description

The Cisco 819 ISRs provide Internet, VPN, data, and backup capability to corporate teleworkers and remote and small offices of fewer than 20 users. These routers are capable of bridging and multiprotocol routing between LAN and WAN ports and provide advanced features such as antivirus protection.

The Cisco 819 ISRs are fixed-configuration data routers that provide four 10/100 Fast Ethernet (FE), 1 Gigabit Ethernet (GE), and WAN connections over Serial and Cellular (3G) interface.

The Cisco 819HGW and Cisco 819HWD ISRs support WiFi radios (AP802H-AGN). A Wireless Local Area Network (WLAN) implements a flexible data communication system frequently augmenting rather than replacing a wired LAN within a building or campus. WLANs use radio frequency to transmit and receive data over the air, minimizing the need for wired connections.

The Cisco 819HG-4G and Cisco 819G-4G support multimode 4G LTE and have embedded Sierra Wireless multimode modem.

Note Cisco 819 ISR is used to refer to Cisco 819G , Cisco 819HG, Cisco 819H, Cisco 819HWD, Cisco 819HGW, Cisco 819HG-4G, and Cisco 819G-4G ISRs unless specifically called out otherwise.

Figure 1-1 shows the Cisco 819HG ISR.

Figure 1-1 Cisco 819HG Integrated Services Router

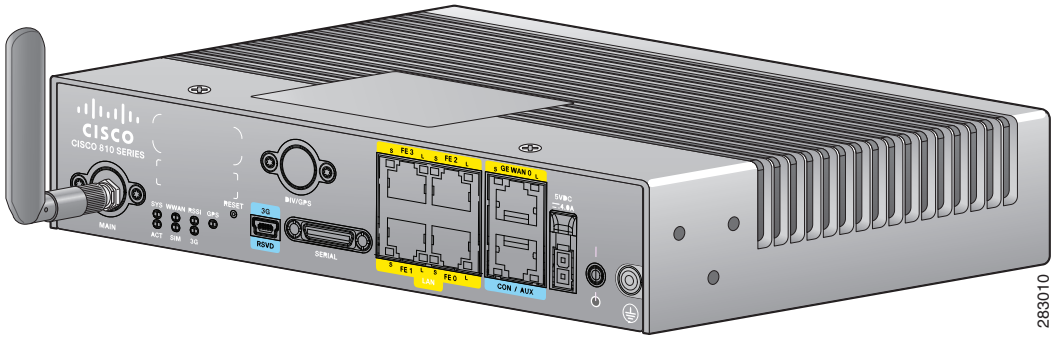
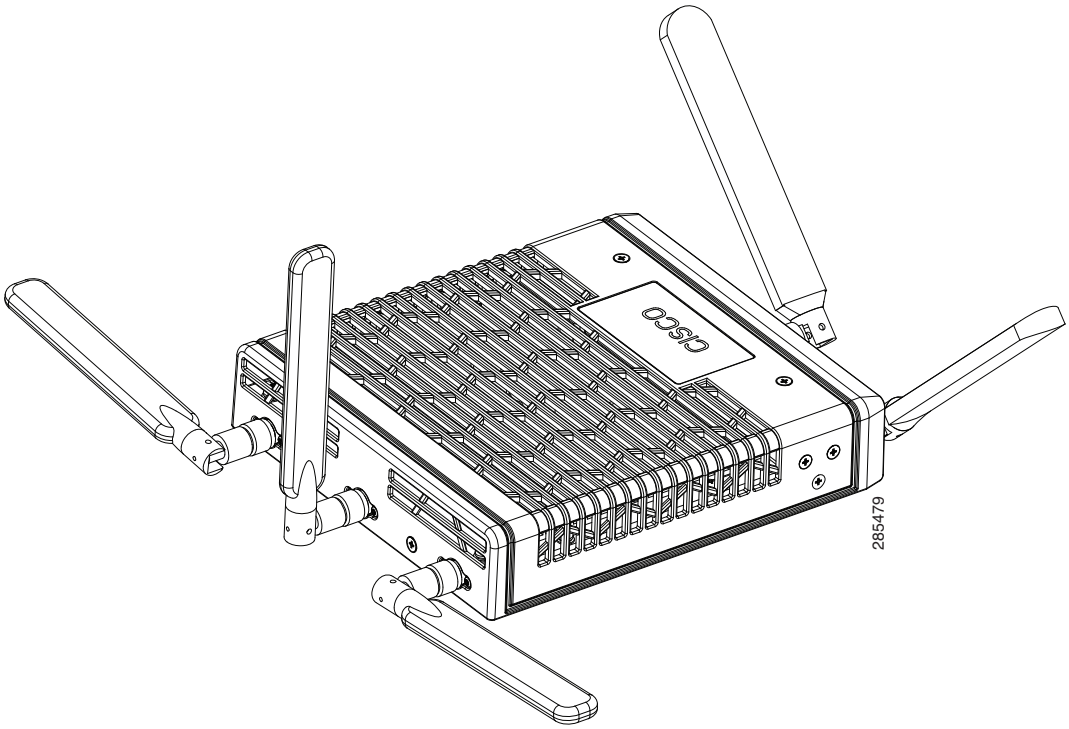


Figure 1-2 shows the Cisco 819HGW ISR.

Figure 1-2 Cisco 819HGW Integrated Services Router



SKU Information

For the complete list of SKUs available in Cisco 819 ISRs, see *SKU Information*.

New Features

This section lists the software, platform, and security features supported by the Cisco 819 ISRs.

- 3G Features, page 1-3
- WLAN Features, page 1-4
- 4G LTE Features, page 1-4
- Platform Features, page 1-4
- Security Features, page 1-4

Note The WAAS Express feature is not supported. This feature will be supported for 3G and 4G interfaces with later IOS releases.

3G Features

- Modem control and management
- Asynchronous transport (AT) command set
- Wireless Host Interface Protocol (WHIP)
- Control and Status (CNS) for out-of-band modem control and status
- Diagnostic Monitor (DM) logging
- Account provisioning
- Modem firmware upgrade
- SIM locking and unlocking
- MEP unlocking
- OMA-DM activation
- Dual SIM card slots
- Link persistence
- SMS Services
- Global Positioning System (GPS) Services
- 3G MIB

WLAN Features

- Dual Radio
- CleanAir Technology
- Dynamic Frequency Selection

4G LTE Features

- IPv4 bearer
- MIPv4, NEMOv4, RFC 3025
- IPv4 subnet behind LTE UE interface
- Evolved High-Rate Packet Data (EHRPD), which allows seamless handoff between 4G LTE and 3G services (C819(H)G-4G-V-K9 only)
- Seamless hand-off between LTE and EHRPD network (C819(H)G-4G-V-K9 only)
- Support for UMTS service as a fallback option from LTE service (C819(H)G-4G-A-K9 and C819(H)G-4G-G-K9 only)
- Seamless handoff between LTE and UMTS service (C819(H)G-4G-A-K9 and C819(H)G-4G-G-K9 only)
- Remote access to Qualcomm diagnostic monitor port
- OTA-DM including wireless configuration FOTA (C819(HG-4G-V-K9 only)
- Mini USB type 2 connector for modem provisioning

Platform Features

For the complete list of Cisco 819 ISR platform features, see *Platform Features for Cisco 819 ISRs*.

Security Features

The Cisco 819 ISRs provide the following security features:

- Intrusion Prevention System (IPS)
- Dynamic Multipoint VPN (DMVPN)
- IPsec
- Quality of service (QoS)
- Firewall
- URL filtering

CHAPTER 2

Wireless Device Overview

The Cisco 819 ISRs provide Internet, VPN, data, and backup capability to corporate teleworkers and remote and small offices of fewer than 20 users. These fixed routers are capable of bridging and multiprotocol routing between LAN and WAN ports and provide advanced features such as antivirus protection.

The fixed 3G routers can be used as the primary WAN connectivity and as a backup for critical applications and can also be used as the primary WAN connection.

Note There are two SIM card slots in the Cisco 819 ISRs. For information on how to install the SIM cards, see *Cisco 819 Integrated Services Router Hardware Installation Guide*.

- ScanSafe, page 2-1
- TFTP support with Ethernet WAN interface, page 2-2
- LEDs, page 2-2

ScanSafe

The Cisco Integrated Services Router G2 (ISR G2) family delivers numerous security services, including firewall, intrusion prevention, and VPN. These security capabilities have been extended with Cisco ISR Web Security with Cisco ScanSafe for a web security and web filtering solution that requires no additional hardware or client software.

Cisco ISR Web Security with Cisco ScanSafe enables branch offices to intelligently redirect web traffic to the cloud to enforce granular security and acceptable use policies over user web traffic. With this solution, you can deploy market-leading web security quickly and can easily protect branch office users from web-based threats, such as viruses, while saving bandwidth, money, and resources.

For more information, see *Cisco ISR Web Security with Cisco ScanSafe Solution Guide*.

TFTP support with Ethernet WAN interface

Trivial File Transfer Protocol (TFTP) is a file transfer protocol notable for its simplicity. It is generally used for automated transfer of configuration or boot files between machines in a local environment.

The Cisco 819H ISR supports TFTP with Ethernet WAN interface that supports data transfer rate of 10 Mbps.

For more information, see the "Using the TFTP Download Command" section on page C-5.

Note This feature is supported in all Cisco 819 ISRs that have ROMMON version 15.2(2r)T and above.

Note TFTP download using switch port is supported in Cisco 819HGW SKUs only.

LEDs

The LED is located on the front panel of the router. Table 2-1 describes the 3G LED for the Cisco 819 ISR.

Table 2-1 3G LED Descriptions

LED	Color	Description
SYS	Yellow	FPGA download is complete.
	Green (blinking)	ROMMON is operational.
	Green (solid)	IOS is operational.
	Green (four blinks during bootup)	Reset button has been pushed during the bootup.
	Off	After powering up, when FPGA is being downloaded (in ROMMON).
ACT	Green	Network activity on FE Switch ports, GE WAN port, 3G cellular interface, and serial interfaces.
	Off	No network activity.
WWAN	Green	Module is powered on and connected but not transmitting or receiving.
	Green (slow blinking)	Module is powered on and searching for connection.
	Green (fast blinking)	Module is transmitting or receiving.
	Off	Module is not powered.
GPS	Green (solid)	Standalone GPS.
	Green (slow blinking)	GPS is acquiring.
	Yellow (solid)	Assisted GPS.
	Yellow (slow blinking)	Assisted GPS is acquiring.
	Off	GPS is not configured.

Table 2-1 3G LED Descriptions (continued)

LED	Color	Description
RSSI	Green (solid)	Signal > –60 Very strong signal
	Green (four blinks and then a long pause)	Signal <= –60 to 74 Strong signal
	Green (two blinks and then a long pause)	Signal <= –75 to –89 Fair signal
	Green (one blink and then a long pause)	Signal <= –90 to –109 Marginal signal
	Off	Signal <= –110 Unusable signal
SIM[1,2]	Green / Yellow (one green blink followed by two yellow blinks)	SIM in slot 0 active, SIM in slot 1 is not.
	Yellow / Green (one yellow blink followed by two greenblinks)	SIM in slot 1 active, SIM in slot 0 is not.
	Off / Green (two green blinks and then pause)	No SIM in slot 0, SIM present in slot 1.
	Green / Off (Slow single green blink and then pause)	SIM present in slot0, no SIM in slot 1.
	Off / Off	No SIM present in either slots.
3G	One blink green and then pause	For 1xRTT, EGPRS, GPRS service.
	Two blink green and then pause	For EVDO, EVDO/1xRTT, UMTS.
	Three blink green and then pause	For EVDO/1xRTT RevA, HSPA, HSUPA/HSDPA.
	Green (solid)	For HSPA PLUS.

1. Not applicable to Verizon and Sprint EVDO modems.
2. There is only one LED to indicate the status two SIMs. A one-blink pattern represents the status of the SIM in slot 0, followed by a two-blink pattern for the SIM in slot 1.

Use the following show commands to check the LED status for your router:

- **show platform led** (for all LEDs)
- **show controller cellular 0** (for 3G LEDs)

The following is a sample output from the **show platform led** command and shows the LED status:

```
router# show platform led
```

```
LED STATUS:
==========
LEDS   :  SYSTEM   WWAN           RSSI            GPS
STATUS:  GREEN    GREEN          GREEN(2 BLINK)  OFF

LEDS   :  ACTIVITY   SIM(slot0  / slot1)          3G
STATUS:  OFF            GREEN  / YELLOW          GREEN


LAN PORTS       :  FE0      FE1      FE2      FE3
LINK/ENABLE LED :  OFF      OFF      OFF      OFF
SPEED LED       :  Unknown  Unknown  Unknown  Unknown


PORT            :  GE-WAN0
LINK/ENABLE LED :  OFF
SPEED LED       :  Unknown
```

The following is a sample output from the **show controllers cellular** command showing the 3G LED status:

```
router# show controllers cellular 0

Interface Cellular0
3G Modem-QuadBand HSPA+R7/HSPA/UMTS QuadBand EDGE/GPRS Global and GPS,
Cellular modem configuration:
---------------------------
GSM-Carrier Type  : Cellular GSM Global.
SKU (PRI) Value: 9900198    .

Modem is recognized as valid
manufacture id:  0x00001199     product id: 0x000068A3
Sierra Wireless Mini Card MC8705 HSPA+R7 modem.

Cellular Dual SIM details:
---------------------------

SIM 0 is present
SIM 0 is active SIM

Modem Management Statistics
---------------------------
Modem resets = 2
Last known modem state = 'application' mode
Packets sent = 2508, Packets received = 44621, Packets pending = 0
DIP MDM link status retry count = 0 pdp context = 0
DIP MDM link up pending = 0 pdp context = 0
IDB Cellular0: DIP profile id = 255
RSSI LED    : 3-blink Green      <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
Service LED : 3-blink Green      <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
SIM LED     : Slot0 - Green;    Slot1 - Off    <<<<<<<<<<<<<<<<<<<<<<<<
GPS LED     : Off                <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
GPS NMEA port = Disabled   (Stream OFF)
DM port = Disabled
    :
    :
    :
B
```

CHAPTER 3

Wireless Local Area Network

A Wireless Local Area Network (WLAN) implements a flexible data communication system frequently augmenting rather than replacing a wired LAN within a building or campus. WLANs use radio frequency to transmit and receive data over the air, minimizing the need for wired connections.

The Cisco 819HGW and Cisco 819HWD ISRs have a Host router software running on the first core. The second core runs the WLAN Access Point software.

If WLAN is not supported in an SKU, all 1 GB DRAM memory is allocated to the first core. For the SKUs that support WLAN, 128 MB out of the 1 GB main memory is allocated to the second core.

If WLAN is not supported in an SKU, all 1 GB compact flash memory is allocated to the first core. For the SKUs that support WLAN, 64 MB out of the 1 GB main memory is allocated to the second core.

Note WLAN is only supported on Cisco 819HGW and Cisco 819HWD ISRs introduced in IOS release 15.2(4)M1.

WLAN Features

The Cisco 819HGW and Cisco 819HWD ISRs support the following features:

- Dual-Radio, page 3-1
- Images Supported, page 3-2
- CleanAir Technology, page 3-2
- Dynamic Frequency Selection, page 3-2
- LEDs, page 3-2

Dual-Radio

This release supports Cisco 802 Access Points (AP802). The AP802 is an integrated access point on the Next Generation of Cisco 819HGW Cisco 819HWD ISRs.

The access point is a wireless LAN transceiver that acts as the connection point between wireless and wired networks or as the center point of a standalone wireless network. In large installations, the roaming functionality provided by multiple access points enables wireless users to move freely throughout the facility while maintaining uninterrupted access to the network.

AP802 Dual Radio contains two different types of wireless radio that can support connections on both 2.4 GHz used by 802.11b, 802.11g, and 802.11n and 5 GHz used by 802.11a and 802.11n.

With the dual-radio/dual-band IEEE 802.11n access point, the Cisco 819HGW and Cisco 819HWD ISRs offer a secure, integrated access point in a single device. The ISRs support both autonomous and unified modes and are backward compatible with 802.11a/b/g.

The routers support IEEE 802.11n draft 2.0 and use multiple-input, multiple-output (MIMO) technology that provides increased throughput, reliability, and predictability.

For complete information on how to configure wireless device and radio settings, see *Basic Wireless Device Configuration* and *Configuring Radio Settings*.

Images Supported

For the images supported in the AP802 Dual radio, see *Minimum software version needed to support AP802*.

CleanAir Technology

The CleanAir is a new wireless technology that intelligently avoids Radio Frequency (RF) to protect 802.11n performance. For more information, see *Cisco CleanAir Technology.* This feature is supported in all SKUs.

Dynamic Frequency Selection

The Dynamic Frequency Selection (DFS) is the process of detecting radar signals that must be protected against 802.11a interference and upon detection switching the 802.11a operating frequency to one that is not interfering with the radar systems. Transmit Power Control (TPC) is used to adapt the transmission power based on regulatory requirements and range information.

Note The DFS functionality is disabled for FCC SKUs pending FCC certification. For more information, see *Dynamic Frequency Selection and IEEE 802.11h Transmit Power Control.*

LEDs

The WLAN LED is located at the front panel of the router. Table 3-1 describes the WLAN LED for the Cisco 819HGW and Cisco 819HWD ISRs.

Table 3-1 WLAN LED Descriptions

WLAN LED	Color	Description
Boot loader status sequence	Blinking Green	Board initialization in progress.
		Initializing FLASH file system.
		Initializing Ethernet.
		Ethernet is OK.
		Starting Cisco IOS.
		Initialization successful.
Association status	Green	Normal operating condition with no wireless client associated.
	Blue	Normal operating condition with at least one wireless client associated.
Operating status	Blinking Blue	Software upgrade in progress.
	Rapidly cycling through Blue, Green, Red, and White	Access point location command invoked.
	Blinking Red	Ethernet link not operational.
Boot loader errors	Blinking Red and Blue	FLASH file system failure.
	Blinking Red and Off	Environment variable failure.
		Bad MAC address.
		Ethernet failure during image recovery.
		Boot environment failure.
		No Cisco image file.
		Boot failure.
Cisco IOS errors	Red	Software failure. Try to disconnect and reconnect the unit power.

CHAPTER 4

4G LTE Wireless WAN

The Cisco 819HG-4G and Cisco 819G-4G LTE ISRs support 4G LTE and 3G cellular networks.

For instructions on how to configure the 4G LTE features on your Cisco 819 ISR, see the *Cisco 4G LTE Software Installation Guide*.

CHAPTER 5

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.

- Interface Ports, page 5-2
- Default Configuration, page 5-2
- Information Needed for Configuration, page 5-3
- Configuring Command-Line Access, page 5-5
- Configuring Global Parameters, page 5-8
- Configuring WAN Interfaces, page 5-9
- Configuring a Loopback Interface, page 5-25
- Configuring Static Routes, page 5-27
- Configuring Dynamic Routes, page 5-28

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

Note For instructions on how to configure the 4G LTE features on your Cisco 819 ISR, see the Cisco 4G LTE Software Installation Guide.

This chapter includes configuration examples and verification steps, as available.

For complete information on how to access global configuration mode, see the "Entering Global Configuration Mode" section on page A-5.

Interface Ports

Table 5-1 lists the interfaces that are supported for each router and their associated port labels on the equipment.

Table 5-1 Supported Interfaces and Associated Port Labels by Cisco Router

Router	Interface	Port Label
Cisco 819 Router	4-port Fast Ethernet LAN	LAN, FE0–FE3
	Gigabit Ethernet WAN	GE WAN 0
	Serial	Serial
	Mini USB for 3G port Provisioning	3G RSVD
	Console/Aux port	CON/AUX

Note There are two labels for the associated antennas with the labels: Main and DIV/GPS.

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 (NAT) has been assigned. Use the **show running-config** command to view the initial configuration, as shown in the following example for a Cisco 819 ISR:

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

Current configuration : 977 bytes
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
no aaa new-model
ip source-route
ip cef

no ipv6 cef
license udi pid CISCO819G-G-K9 sn FHK1429768Q
controller Cellular 0
interface Cellular0
 no ip address
 encapsulation ppp
interface Ethernet-wan0
 no ip address
 shutdown
 duplex auto
```

```
 speed auto
interface FastEthernet0
interface FastEthernet1
interface FastEthernet2
interface FastEthernet3
interface Serial0
 no ip address
 shutdown
 no fair-queue
 clock rate 2000000
!
interface Vlan1
 no ip address
!
ip forward-protocol nd
no ip http server
no ip http secure-server

logging esm config

control-plane
line con 0
 no modem enable
line aux 0
line 3
 no exec
line 7
 stopbits 1
 speed 115200
line vty 0 4
 login
 transport input all
!
scheduler allocate 20000 1000
end
```

Information Needed for Configuration

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

- If you are setting up an Internet connection, gather the following information:
  - 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.
- If you are setting up the serial interface:
  - Mode of operation (sync, async, bisync)
  - Clock rate depending on the mode
  - IP address depending on the mode
- If you are setting up 3G:
  - You must have service availability on the Cisco 819 ISR from a carrier, and you must have network coverage where your router will be physically placed. For a complete list of supported carriers, see the data sheet at *Cisco 3G Wireless Connectivity Solutions*.
  - You must subscribe to a service plan with a wireless service provider and obtain a SIM card.
  - You must install the SIM card before configuring the 3G Cisco 819 ISR. For instructions on how to install the SIM card, see *Cisco 800 Series RoutersConfiguring Cisco EHWIC and 880G for 3.7G (HSPA+)/3.5G (HSPA)*.
- You must install the required antennas before you configure the 3G for Cisco 819 ISR. See the following URLs for instructions on how to install the antennas:
  - 3G-ANTM1919D—See *Cisco Multiband Swivel-Mount Dipole Antenna (3G-ANTM1919D)*.
  - 3G-ANTM1916-CM—See *Cisco Multiband Omnidirectional Ceiling Mount Antenna (3G-ANTM1916-CM).*
  - 3G-AE015-R (Antenna Extension)—See *Cisco Single-Port Antenna Stand for Multiband TNC Male-Terminated Portable Antenna (Cisco 3G-AE015-R).*
  - 3G-AE010-R (Antenna Extension)—See *Cisco Single-Port Antenna Stand for Multiband TNC Male-Terminated Portable Antenna (Cisco 3G-AE015-R).* This document applies to both 3G-AE015-R and 3G-AE010-R. The only difference between these two products is the length of the cable.
  - 3G-ANTM-OUT-OM—See *Cisco 3G Omnidirectional Outdoor Antenna (3G-ANTM-OUT-OM)*.
  - 3G-ANTM-OUT-LP—See *Cisco Multiband Omnidirectional Panel-Mount Antenna (3G-ANTM-OUT-LP).*
  - 3G-ACC-OUT-LA—See *Cisco 3G Lightning Arrestor (3G-ACC-OUT-LA).*
  - 4G-ANTM-OM-CM—See *Cisco 4G Indoor Ceiling-Mount Omnidirectional Antenna (4G-ANTM-OM-CM)*.
- You must check your LEDs for signal reception as described in Table 2-1.
- You should be familiar with the Cisco IOS software. See the *Cisco IOS documentation* beginning with Release 12.4(15)T or later for Cisco 3G support.
- To configure your 3G data profile, you will need the username, password, and access point name (APN) from your service provider:

After you have collected the appropriate information, you can perform a full configuration on your router, beginning with the tasks in the "Configuring Command-Line Access" section on page 5-5.

To obtain or change software licenses:

- See *Software Activation on Cisco Integrated Services Routers and Cisco Integrated Service Routers G2.*

Configuring Command-Line Access

To configure parameters to control access to the router, perform the following steps, beginning in global configuration mode:

SUMMARY STEPS

1. **line** [**aux** | **console** | **tty** | **vty**] *line-number*
2. **password** *password*
3. **login**
4. **exec-timeout** *minutes* [*seconds*]
5. **line** [**aux** | **console** | **tty** | **vty**] *line-number*
6. **password** *password*
7. **login**
8. **end**

DETAILED STEPS

	Command	Purpose

Step 1	**line** [**aux** | **console** | **tty** | **vty**] *line-number*
	
	Example:
	`Router(config)# line console 0`
	`Router(config-line)#`
		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-line)#`
		Specifies a unique password for the console terminal line.

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

Step 4	**exec-timeout** *minutes* [*seconds*]
	
	Example:
	`Router(config-line)# exec-timeout 5 30`
	`Router(config-line)#`
		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)# line vty 0 4`
	`Router(config-line)#`
		Specifies a virtual terminal for remote console access.

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

	Command	Purpose

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

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

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 Global Parameters

To configure selected global parameters for your router, perform these steps:

SUMMARY STEPS

1. **configure terminal**
2. **hostname** *name*
3. **enable secret** *password*
4. **no ip domain-lookup**

DETAILED STEPS

	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.

Configuring WAN Interfaces

Configure the WAN interface for your router using one of the following as appropriate:

- Configuring a Gigabit Ethernet WAN Interface, page 5-9
- Configuring the Cellular Wireless WAN Interface, page 5-10
- Configuring Dual SIM for Cellular Networks, page 5-22
- Configuring Router for Image and Config Recovery Using Push Button, page 5-23

- Configuring Router for Image and Config Recovery Using Push Button, page 5-23

Configuring a Gigabit Ethernet WAN Interface

To configure the Ethernet interface on a Cisco 819 ISR, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **interface** *type number*
2. **ip address** *ip-address mask*
3. **no shutdown**
4. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface gigabitethernet 0`
	`Router(config-if)#`
		Enters the configuration mode for a Gigabit Ethernet WAN interface on the router.

Step 2	**ip address** *ip-address mask*
	
	Example:
	`Router(config-if)# ip address 192.168.12.2 255.255.255.0`
	`Router(config-if)#`
		Sets the IP address and subnet mask for the specified Gigabit Ethernet interface.

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

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

Configuring the Cellular Wireless WAN Interface

The Cisco 819 ISRs provide a Third-Generation (3G) wireless interface for use over Global System for Mobile Communications (GSM) and code division multiple access (CDMA) networks. The interface is a 34-millimetre embedded mini express card.

Its primary application is WAN connectivity as a backup data link for critical data applications. However, the 3G wireless interface can also function as the router's primary WAN connection.

To configure the 3G cellular wireless interface, follow these guidelines and procedures:

- Prerequisites for Configuring the 3G Wireless Interface, page 5-11
- Restrictions for Configuring the Cellular Wireless Interface, page 5-11
- Data Account Provisioning, page 5-12
- Configuring a Cellular Interface, page 5-16
- Configuring DDR, page 5-17
- Examples for Configuring Cellular Wireless Interfaces, page 5-20
- Configuring Dual SIM for Cellular Networks, page 5-22

Prerequisites for Configuring the 3G Wireless Interface

The following are prerequisites to configuring the 3G wireless interface:

- You must have wireless service from a carrier, and you must have network coverage where your router will be physically placed. For a complete list of supported carriers, see the data sheet at:

  www.cisco.com/go/m2m

- You must subscribe to a service plan with a wireless service provider and obtain a SIM card (GSM modem only) from the service provider.
- You must check your LEDs for signal strength, as described in Table 2-1.
- You should be familiar with the Cisco IOS software. See *Cisco IOS documentation* beginning with Cisco IOS Release 12.4(15)XZ or later for Cisco 3G Wireless support.
- To configure your GSM data profile, you need the following information from your service provider:
  - Username
  - Password
  - Access point name (APN)
- To configure your CDMA (CDMA only) data profile for manual activation, you need the following information from your service provider:
  - Master Subsidy Lock (MSL) number
  - Mobile Directory number (MDN)
  - Mobile Station Identifier (MSID)
  - Electronic Serial Number (ESN)
- Check the LED located on the front panel of the router for signal strength and other indications. Table 2-1 describes the 3G LEDs for the Cisco 819 ISR.

Restrictions for Configuring the Cellular Wireless Interface

The following restrictions apply to configuring the Cisco 3G wireless interface:

- A data connection can be originated only by the 3G wireless interface. Remote dial-in is not supported.
- Because of the shared nature of wireless communications, the experienced throughput varies depending on the number of active users or the amount of congestion in a given network.
- Cellular networks have higher latency than wired networks. Latency rates depend on the technology and carrier. Latency may be higher when there is network congestion.
- VoIP is currently not supported.
- Any restrictions that are part of the terms of service from your carrier also apply to the Cisco 3G wireless interface.
- Inserting a different type of modem from what was previously removed requires configuration changes and you must reload the system.

Data Account Provisioning

Note To provision your modem, you must have an active wireless account with a service provider. A SIM card must be installed in a GSM 3G wireless card.

To provision your data account, follow these procedures:

- Verifying Signal Strength and Service Availability, page 5-12
- Configuring a GSM Modem Data Profile, page 5-13
- CDMA Modem Activation and Provisioning, page 5-14

Verifying Signal Strength and Service Availability

To verify the signal strength and service availability on your modem, use the following commands in privileged EXEC mode.

SUMMARY STEPS

1. **show cellular 0 network**
2. **show cellular 0 hardware**
3. **show cellular 0 connection**
4. **show cellular 0 gps**
5. **show cellular 0 radio**
6. **show cellular 0 profile**
7. **show cellular 0 security**
8. **show cellular 0 sms**
9. **show cellular 0 all**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show cellular 0 network** **Example:** `Router# show cellular 0 network`	Displays information about the carrier network, cell site, and available service.
Step 2	**show cellular 0 hardware** **Example:** `Router# show cellular 0 hardware`	Displays the cellular modem hardware information.
Step 3	**show cellular 0 connection** **Example:** `Router# show cellular 0 connection`	Displays the current active connection state and data statistics.

	Command or Action	Purpose
Step 4	**show cellular 0 gps** **Example:** `Router# show cellular 0 gps`	Displays the cellular gps information.
Step 5	**show cellular 0 radio** **Example:** `Router# show cellular 0 radio`	Shows the radio signal strength. **Note** The RSSI should be better than –90 dBm for steady and reliable connection.
Step 6	**show cellular 0 profile** **Example:** `Router# show cellular 0 profile`	Shows information about the modem data profiles created.
Step 7	**show cellular 0 security** **Example:** `Router# show cellular 0 security`	Shows the security information for the modem, such as SIM and modem lock status.
Step 8	**show cellular 0 sms** **Example:** `Router# show cellular 0 sms`	Displays the cellular sms information.
Step 9	**show cellular 0 all** **Example:** `Router# show cellular 0 all`	Shows consolidated information about the modem, such as the profiles that were created, the radio signal strength, the network security, and so on.

Configuring a GSM Modem Data Profile

To configure or create a new modem data profile, enter the following command in privileged EXEC mode.

SUMMARY STEPS

1. **cellular 0 gsm profile create <profile number> <apn> <authentication> <username> <password> ipv4**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**cellular 0 gsm profile create <profile number> <apn> <authentication> <username> <password> ipv4** **Example:** `Router# gsm profile create 2 <apn-name> chap username password ipv4`	Creates a new modem data profile. See Table 5-2 for details about the command parameters.

Table 5-2 lists the modem data profile parameters.

Table 5-2 Modem Data Profile Parameters

profile number	Number for the profile that you are creating. You can create up to 16 profiles.
apn	Access point name. You must get this information from the service provider.
authentication	Type of authentication, for example, CHAP, PAP.
Username	Username provided by your service provider.
Password	Password provided by your service provider.

CDMA Modem Activation and Provisioning

Activation procedures may differ, depending upon your carrier. Consult your carrier and perform one of the following procedures as appropriate:

- Manual activation
- Activating using over-the-air service provisioning

The following table lists the activation and provisioning processes supported by different wireless carriers.

Table 5-3

Activation and Provisioning Process	Carrier
Manual Activation using MDN, MSID, MSL	Sprint
OTASP[1] Activation	Verizon Wireless
IOTA[2] for Data Profile refresh	Sprint

1. OTASP = Over the Air Service Provisioning.
2. IOTA = Internet Over the Air.

Manual Activation

Note You must have valid mobile directory number (MDN), mobile subsidy lock (MSL), and mobile station identifier (MSID) information from your carrier before you start this procedure.

To configure a modem profile manually, use the following command, beginning in EXEC mode:

cellular *unit* **cdma activate manual** *mdn msid msl*

Besides being activated, the modem data profile is provisioned through the Internet Over the Air (IOTA) process. The IOTA process is initiated automatically when you use the **cellular** *unit* **cdma activate manual** *mdn msid msl* command.

The following is a sample output from this command:

```
router# cellular 0 cdma activate manual 1234567890 1234567890 12345
NAM 0 will be configured and will become Active
Modem will be activated with following Parameters
MDN :1234567890; MSID :1234567890; SID :1234; NID 12:
Checking Current Activation Status
Modem activation status: Not Activated
Begin Activation
```

```
Account activation - Step 1 of 5
Account activation - Step 2 of 5
Account activation - Step 3 of 5
Account activation - Step 4 of 5
Account activation - Step 5 of 5
Secure Commit Result: Succeed
Done Configuring - Resetting the modem
The activation of the account is Complete
Waiting for modem to be ready to start IOTA
Beginning IOTA
router#
*Feb  6 23:29:08.459: IOTA Status Message Received. Event: IOTA Start, Result: SUCCESS
*Feb  6 23:29:08.459: Please wait till IOTA END message is received
*Feb  6 23:29:08.459: It can take up to 5 minutes
*Feb  6 23:29:27.951: OTA State = SPL unlock, Result = Success
*Feb  6 23:29:32.319: OTA State = Parameters committed to NVRAM, Result = Success
*Feb  6 23:29:40.999: Over the air provisioning complete; Result:Success
*Feb  6 23:29:41.679: IOTA Status Message Received. Event: IOTA End, Result: SUCCESS
```

The IOTA start and end must have “success” as the resulting output. If you receive an error message, you can run IOTA independently by using the **cellular cdma activate iota** command.

Your carrier may require periodic refreshes of the data profile. Use the following command to refresh the data profile:

cellular cdma activate iota

Activating with Over-the-Air Service Provisioning

To provision and activate your modem using Over-the-Air Service Provisioning (OTASP), use the following command, beginning in EXEC mode.

router # **cellular 0 cdma activate otasp** *phone_number*

Note You need to obtain the phone number for use with this command from your carrier. The standard OTASP calling number is *22899.

The following is a sample output from this command:

```
router# cellular 0 cdma activate otasp  *22899
Beginning OTASP activation
OTASP number is *22899
819H#
OTA State = SPL unlock, Result = Success
router#
OTA State = PRL downloaded, Result = Success
OTA State = Profile downloaded, Result = Success
OTA State = MDN downloaded, Result = Success
OTA State = Parameters committed to NVRAM, Result = Success
Over the air provisioning complete; Result:Success
```

Configuring a Cellular Interface

To configure the cellular interface, enter the following commands, beginning in privileged EXEC mode.

SUMMARY STEPS

1. **configure terminal**
2. **interface cellular 0**
3. **encapsulation ppp**
4. **ppp chap hostname** *hostname*
5. **ppp chap password 0** *password*
6. **asynchronous mode interactive**
7. **ip address negotiated**

Note The PPP Challenge Handshake Authentication Protocol (CHAP) authentication parameters that you use in this procedure must be the same as the username and password provided by your carrier and configured only under the GSM profile. CDMA does not require a username or password.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode from the terminal.
Step 2	**interface cellular 0** **Example:** `Router (config)# interface cellular 0`	Specifies the cellular interface.
Step 3	**encapsulation ppp** **Example:** `Router (config-if)# encapsulation ppp`	Specifies PPP encapsulation for an interface configured for dedicated asynchronous mode or dial-on-demand routing (DDR).
Step 4	**ppp chap hostname** *hostname* **Example:** `Router (config-if)# ppp chap hostname cisco@wwan.ccs`	Defines an interface-specific Challenge Handshake Authentication Protocol (CHAP) hostname. This must match the username given by the carrier. Applies to GSM only.
Step 5	**ppp chap password 0** *password* **Example:** `Router (config-if)# ppp chap password 0 cisco`	Defines an interface-specific CHAP password. This must match the password given by the carrier.

	Command or Action	Purpose
Step 6	**asynchronous mode interactive** **Example:** `Router (config-if)# asynchronous mode interactive`	Returns a line from dedicated asynchronous network mode to interactive mode, enabling the **slip** and **ppp** commands in privileged EXEC mode.
Step 7	**ip address negotiated** **Example:** `Router (config-if)# ip address negotiated`	Specifies that the IP address for a particular interface is obtained via PPP and IPCP address negotiation.

Note When the cellular interface requires a static IP address, the address may be configured as **ip address negotiated**. Through IP Control Protocol (IPCP), the network ensures that the correct static IP address is allocated to the device. If a tunnel interface is configured with the **ip address unnumbered** <*cellular interface*> command, the actual static IP address must be configured under the cellular interface, in place of **ip address negotiated**. For a sample cellular interface configuration, see the "Basic Cellular Interface Configuration" section on page 5-20.

Configuring DDR

Perform these steps to configure dial-on-demand routing (DDR) for the cellular interface.

SUMMARY STEPS

1. **configure terminal**
2. **interface cellular 0**
3. **dialer in-band**
4. **dialer idle-timeout** *seconds*
5. **dialer string** *string*
6. **dialer group** *number*
7. **exit**
8. **dialer-list** *dialer-group* **protocol** *protocol-name* **{permit | deny | list** *access-list-number* **| access-group}**
9. **ip access-list** <*access list number*> **permit** <*ip source address*>
10. **line 3**
11. **script dialer <regexp>**
12. **exit**
13. **chat-script <script name> "" "ATDT*99*<profile number>#" TIMEOUT <timeout value> CONNECT**
    or
    chat-script <script name> "" "ATDT*777*<profile number>#" TIMEOUT <timeout value> CONNECT
14. **interface cellular 0**
15. **dialer string** <*string*>

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 2	**interface cellular 0** **Example:** `Router (config)# interface cellular 0`	Specifies the cellular interface.
Step 3	**dialer in-band** **Example:** `Router (config-if)# dialer in-band`	Enables DDR and configures the specified serial interface for in-band dialing.
Step 4	**dialer idle-timeout** *seconds* **Example:** `Router (config-if)# dialer idle-timeout 30`	Specifies the duration of idle time, in seconds, after which a line is disconnected.
Step 5	**dialer string** *string* **Example:** `Router (config-if)# dialer string gsm`	Specifies the number or string to dial. Use the name of the chat script here.
Step 6	**dialer-group** *number* **Example:** `Router (config-if)# dialer-group 1`	Specifies the number of the dialer access group to which a specific interface belongs.
Step 7	**exit** **Example:** `Router (config-if)# exit`	Enters the global configuration mode.
Step 8	**dialer-list** *dialer-group* **protocol** *protocol-name* {**permit** | **deny** | **list** *access-list-number* | **access-group**} **Example:** `Router (config)# dialer-list 1 protocol ip list 1`	Creates a dialer list for traffic of interest and permits access to an entire protocol.
Step 9	**ip access-list** *<access list number>* **permit** *<ip source address>* **Example:** `Router (config)# ip access list 1 permit any`	Defines traffic of interest.

	Command or Action	Purpose
Step 10	**line 3** **Example:** Router (config-line)# line 3	Specifies the line configuration mode. It is always 3.
Step 11	**script dialer** <**regexp**> **Example:** Router (config-line)# script-dialer gsm	Specifies a default modem chat script.
Step 12	**exit** **Example:** Router (config-line)# exit	Exits line configuration mode.
Step 13	For GSM: **chat-script <script name> ”” “ATDT*99*<profile number>#” TIMEOUT <timeout value> CONNECT** For CDMA: **chat-script <script name> "" "ATDT*777*<profile number>#" TIMEOUT <timeout value> CONNECT** **Example:** Router (config)# chat-script gsm "" "ATDT*98*2#" TIMEOUT 60 "CONNECT“	Configures this line for GSM. Configures this line for CDMA. Defines the Attention Dial Tone (ATDT) commands when the dialer is initiated.
Step 14	**interface cellular 0** **Example:** Router (config)# interface cellular 0	Specifies the cellular interface.
Step 15	**dialer string** *string* **Example:** Router (config)# dialer string gsm	Specifies the dialer script (defined using the **chat script** command).

Examples for Configuring Cellular Wireless Interfaces

This section provides the following configuration examples:

- Basic Cellular Interface Configuration, page 5-20
- Tunnel over Cellular Interface Configuration, page 5-21
- Configuration for 8705 modem, page 5-21

Basic Cellular Interface Configuration

The following example shows how to configure a gsm cellular interface to be used as a primary WAN connection. It is configured as the default route.

```
chat-script gsm "" "ATDT*98*2#" TIMEOUT 60 "CONNECT"

!
interface Cellular0
 ip address negotiated
 encapsulation ppp
 dialer in-band
 dialer string gsm
 dialer-group 1
 async mode interactive
 ppp chap hostname cisco@wwan.ccs
 ppp chap password 0 cisco
 ppp ipcp dns request
!

ip route 0.0.0.0 0.0.0.0 Cellular0
!
!
access-list 1 permit any
dialer-list 1 protocol ip list 1
!
line 3
 exec-timeout 0 0
 script dialer gsm
 login
 modem InOut
```

The following example shows how to configure a cdma cellular interface to be used as a primary WAN connection. It is configured as the default route.

```
chat-script cdma "" "ATDT#777" TIMEOUT 60 "CONNECT"

!
interface Cellular0
 ip address negotiated
 encapsulation ppp
 dialer in-band
 dialer string cdma
 dialer-group 1
 async mode interactive
 ppp chap password 0 cisco
!

ip route 0.0.0.0 0.0.0.0 Cellular0
!
!
access-list 1 permit any
dialer-list 1 protocol ip list 1
!
```

```
line 3
 exec-timeout 0 0
 script dialer cdma
 login
 modem InOut
```

Tunnel over Cellular Interface Configuration

The following example shows how to configure the static IP address when a tunnel interface is configured with the **ip address unnumbered** <*cellular interface*> command:

```
interface Tunnel2
 ip unnumbered Cellular0
 tunnel source Cellular0
 tunnel destination 128.107.248.254

interface Cellular0
 bandwidth receive 1400000
 ip address 23.23.0.1 255.255.0.0
 ip nat outside
 ip virtual-reassembly
 encapsulation ppp
 no ip mroute-cache
 dialer in-band
 dialer idle-timeout 0
 dialer string dial<carrier>
 dialer-group 1
 async mode interactive
 no ppp lcp fast-start
 ppp chap hostname <hostname>        *** gsm only ***
 ppp chap password 0 <password>
 ppp ipcp dns request

! traffic of interest through the tunnel/cellular interface
ip route 10.10.0.0 255.255.0.0 Tunnel2
```

Configuration for 8705 modem

The following shows how to configure an HSPA+ modem:

```
chat-script hspa "" "AT!SCACT=1,1" TIMEOUT 60 "OK"

interface Cellular0
 ip address negotiated
 encapsulation slip
 dialer in-band
 dialer pool-member 1
 dialer-group 1
 async mode interactive

interface Dialer1
 ip address negotiated
 ip nat outside
 ip virtual-reassembly in
 encapsulation slip
 dialer pool 1
 dialer string hspa
 dialer-group 1

ip nat inside source list 1 interface Dialer1 overload
ip route 0.0.0.0 0.0.0.0 Dialer1
access-list 1 permit any
dialer-list 1 protocol ip permit
```

```
line 3
 script dialer hspa+
 modem InOut
 no exec
 transport input all
```

Configuring Dual SIM for Cellular Networks

The Dual SIM feature implements auto-switch and failover between two cellular networks on a Cisco 819 ISR. This feature is enabled by default with SIM slot 0 being the primary slot and slot 1 being the secondary (failover) slot.

Note For instructions on how to configure the Dual SIM feature for 4G LTE cellular networks, see the *Cisco 4G LTE Software Installation Guide*.

You can configure the Dual SIM feature using the following commands:

Command	Syntax	Description
gsm failovertimer	**gsm failovertimer** <1-7>	Sets the failover timer in minutes.
gsm sim authenticate	**gsm sim authenticate** <0,7> <pin> **slot** <0-1>	Verifies the SIM CHV1 code.
gsm sim max-retry	**gsm sim max-retry** <0-65535>	Specifies the maximum number of failover retries. The default value is 10.
gsm sim primary slot	**gsm sim primary slot** <0-1>	Modifies the primary slot assignment.
gsm sim profile	**gsm sim profile** <1-16> **slot** <0-1>	Configures the SIM profile.

Note the following:

- For auto-switch and failover to work, configure the SIM profile for slots 0 and 1 using the **gsm sim profile** command.
- For auto-switch and failover to work, configure the chat script without a specific profile number.
- If no SIM profile is configured, profile #1 is used by default.
- If no GSM failover timer is configured, the default failover timeout is 2 minutes.
- If no GSM SIM primary slot is configured, the default primary SIM is slot 0.

The following example shows you how to set the SIM switchover timeout period to 3 minutes:

```
router(config-controller)# gsm failovertimer 3
```

The following example shows you how to authenticate using an unencrypted pin:

```
router(config-controller)# gsm sim authenticate 0 1234 slot 0
```

The following example shows you how to set the maximum number of SIM switchover retries to 20:

```
router(config-controller)# gsm sim max-retry 20
```

The following example shows you how to set SIM slot 1 as the primary slot:

```
router(config-controller)# gsm sim primary slot 1
```

The following example shows you how to configure the SIM card in slot 0 to use profile 10:

```
router(config-controller)# gsm sim profile 10 slot 0
```

Perform the following commands to manually switch the SIM:

Command	Syntax	Description
cellular GSM SIM	**cellular GSM SIM** {lock | unlock}	Locks or unlocks the SIM.
gsm sim	**cellular** <unit> **gsm sim** [lock | unlock] <pin>	Locks or unlocks the gsm SIM.
gsm sim unblock	**cellular** <unit> **gsm sim unblock** <puk> <newpin>	Unblocks the gsm SIM.
gsm sim change-pin	**cellular** <unit> **gsm sim change-pin** <oldpin> <newpin>	Changes the PIN of the SIM.
gsm sim activate slot	**cellular** <unit> **gsm sim activate slot** <slot_no>	Activates the GSM SIM.

The following command forces the modem to connect to SIM1:

```
Router# cellular 0 gsm sim activate slot 1
```

Configuring Router for Image and Config Recovery Using Push Button

A push button feature is available on the Cisco 819 ISR. The reset button on the front panel of the router enables this feature.

Perform the following steps to use this feature:

Step 1 Unplug power.

Step 2 Press the reset button on the front panel of the router.

Step 3 Power up the sytem while holding down the reset button.

The system LED blinks four times indicating that the router has accepted the button push.

Using this button takes effect only during ROMMON initialization. During a warm reboot, pressing this button has no impact on performance. Table 5-4 shows the high level functionality when the button is pushed during ROMMON initialization.

Table 5-4 Push Button Functionality during ROMMON Initialization

ROMMON Behavior	IOS Behavior
• Boots using default baud rate. • Performs auto-boot. • Loads the *.default image if available on compact flash **Note** If no *.default image is available, the ROMMON will boot up with the first Cisco IOS image on flash. Examples of names for default images: c800-universalk9-mz.SPA.default, c-800-universalk9_npe-mz.151T.default, image.default **Note** You can only have one configuration file with *.cfg option. Having more than one file will result in uncertain operational behavior.	If the configuration named *.cfg is available in nvram storage or flash storage, IOS will perform a backup of the original configuration and will boot up using this configuration. **Note** You can only have one configuration file with *.cfg option. Having more than one file will result in uncertain operational behavior.

Use the **show platform** command to display the current bootup mode for the router. The following sections show sample outputs when the button is not pushed and when the button is pushed.

Output When Button Is Not Pushed: Example

```
router# show platform boot-record

Platform Config Boot Record :
============================
Configuration Register at boot time : 0x0
Reset Button Status at Boot Time    : Not Pressed
Startup-config Backup Status at Boot: No Status
Startup-config(backup file)location : No Backup
Golden config file at location      : No Recovery Detected
Config Recovery Status              : No Status
```

Output When Button Is Pushed: Example

```
router# show platform boot-record

Platform Config Boot Record :
============================
Configuration Register at boot time : 0x0
Reset Button Status at Boot Time    : Pressed
Startup-config Backup Status at Boot: Ok
Startup-config(backup file)location : flash:/startup.backup.19000716-225840-UTC
Golden config file at location      : flash:/golden.cfg
Config Recovery Status              : Ok
```

Push Button in WLAN AP

When the push button on the front panel is pressed, WLAN AP will perform both image and configuration recovery.

To perform image recovery, WLAN will go into the boot loader so that the user can download the image from the bootloader prompt.

To perform configuration recovery, WLAN AP will overwrite the contents of **flash:/config.txt** with the contents of **flash:/cpconfig-ap802.cfg** file if available in flash drive. Otherwise, **flash:/config.txt** will be deleted.

Configuring the Fast Ethernet LAN Interfaces

The Fast Ethernet LAN interfaces on your router are automatically configured as part of the default VLAN and are not configured with individual addresses. Access is provided through the VLAN. You may assign the interfaces to other VLANs if you want. For more information about creating VLANs, see the "Configuring the Ethernet Switches" section on page 10-1.

Configuring a Loopback Interface

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

Perform these steps to configure a loopback interface, beginning in global configuration mode:

SUMMARY STEPS

1. **interface** *type number*
2. **ip address** *ip-address mask*
3. **exit**

DETAILED STEPS

	Command	Purpose

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

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

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

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 Configuration

To verify that you have properly configured the loopback interface, enter the **show interface loopback** command. You should see a 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 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.

Follow these steps to configure static routes, beginning in global configuration mode.

SUMMARY STEPS

1. **ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]}
2. **end**

DETAILED STEPS

	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 about additional parameters that can be set, see *Cisco IOS IP Routing: Protocol-Independent Command Reference*.

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

For general information on static routing, see the "Floating Static Routes" section on page B-5.

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 command marked "(**default**)." This command appears 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 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 a verification output similar to the following:

```
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 Routing Information Protocol, page 5-29
- Configuring Enhanced Interior Gateway Routing Protocol, page 5-30

Configuring Routing Information Protocol

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

SUMMARY STEPS

1. **router rip**
2. **version** {**1** | **2**}
3. **network** *ip-address*
4. **no auto-summary**
5. **end**

DETAILED STEPS

	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 each directly connected network.

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 classfull network boundaries.

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

For general information on RIP, see the "RIP" section on page B-2.

Example

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

To see this configuration, use the **show running-config** command from privileged EXEC mode.

```
!
Router# show running-config
router rip
 version 2
 network 10.0.0.0
 network 192.168.1.0
 no auto-summary
!
```

Verifying 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 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
R    3.0.0.0/8 [120/1] via 2.2.2.1, 00:00:02, Ethernet0/0
```

Configuring Enhanced Interior Gateway Routing Protocol

To configure Enhanced Interior Gateway Routing Protocol (EIGRP), perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **router eigrp** *as-number*
2. **network** *ip-address*
3. **end**

DETAILED STEPS

	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.

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 general information on EIGRP concept, see the "Enhanced IGRP" section on page B-3.

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 109.

To see this configuration, use the **show running-config** command, beginning in privileged EXEC mode.

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

Verifying 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 a verification output similar to the following:

```
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
```

CHAPTER 6

Configuring Backup Data Lines and Remote Management

This chapter describes configuring backup data lines and remote management in the following sections:

- Configuring Backup Interfaces, page 6-1
- Configuring Cellular Dial-on-Demand Routing Backup, page 6-3
- Configuring Dial Backup and Remote Management Through the Console Port, page 6-8.

The Cisco 819 Integrated Services Router (ISR) supports backup data connectivity with a backup data line that enables them to mitigate WAN downtime.

Cisco 819 ISRs also support remote management functions through the auxiliary port on any Cisco 819 series ISRs.

Note On the Cisco 819 ISRs, the console port and the auxiliary port are on the same physical RJ-45 port. Therefore, the two ports cannot be activated simultaneously. You must use the command-line interface (CLI) to enable the desired function.

Configuring Backup Interfaces

When the router receives an indication that the primary interface is down, the backup interface becomes enabled. After the primary connection has been restored for a specified period, the backup interface is disabled.

Even if the backup interface comes out of standby mode, the router does not enable the backup interface unless the router receives the traffic specified for that backup interface.

Table 6-1 shows the backup interfaces available for each Cisco 819 ISR, along with their port designations. Basic configurations for these interfaces are given in the "Configuring WAN Interfaces" section on page 5-9.

Table 6-1 Model Number and Data Line Backup Capabilities

Router Model Number		3G
819		Yes

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

SUMMARY STEPS

1. **interface** *type number*
2. **backup interface** *interface-type interface-number*
3. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface xxx 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.

Step 2	**backup interface** *interface-type interface-number*
	
	Example:
	`Router(config-if)# backup interface serial 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 serial interface configured as the backup interface for the ATM 0 interface.

Step 3	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits the configuration interface mode.

Configuring Cellular Dial-on-Demand Routing Backup

To monitor the primary connection and initiate the backup connection over the cellular interface when needed, the router can use one of the following methods:

- Backup Interface—The backup interface that stays in standby mode until the primary interface line protocol is detected as down and then is brought up. See the "Configuring Backup Interfaces" section on page 6-1.
- Dialer Watch—Dialer watch is a backup feature that integrates dial backup with routing capabilities. See the "Configuring DDR Backup Using Dialer Watch" section on page 6-3.
- Floating Static Route—The route through the backup interface has an administrative distance that is greater than the administrative distance of the primary connection route and therefore would not be in the routing table until the primary interface goes down. When the primary interaface goes down, the floating static route is used. See the "Configuring DDR Backup Using Floating Static Route" section on page 6-5

Note You cannot configure a backup interface for the cellular interface and any other asynchronous serial interface.

Configuring DDR Backup Using Dialer Watch

To initiate dialer watch, you must configure the interface to perform dial-on-demand routing (DDR) and backup. Use traditional DDR configuration commands, such as dialer maps, for DDR capabilities. To enable dialer watch on the backup interface and create a dialer list, use the following commands in interface configuration mode.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type number*
3. **dialer watch group** *group-number*
4. **dialer watch-list** *group-number* **ip** *ip-address address-mask*
5. **dialer-list** <*dialer-group*> **protocol** <*protocol name*> {**permit** | **deny** | **list** <*access list number*> | **access-group**}
6. **ip access-list** <*access list number*> **permit** <*ip source address*>
7. **interface cellular** *0*
8. **dialer string** <*string*>

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 2	**interface** *type number* **Example:** `Router (config)# interface 0`	Specifies the interface.
Step 3	**dialer watch-group** *group-number* **Example:** `Router(config-if)# dialer watch-group 2`	Enables dialer watch on the backup interface.
Step 4	**dialer watch-list** *group-number* **ip** *ip-address address-mask* **Example:** `Router(config-if)# dialer watch-list 2 ip 10.4.0.254 255.255.0.0`	Defines a list of all IP addresses to be watched.
Step 5	**dialer-list** *<dialer-group>* **protocol** *<protocol-name>* {**permit** | **deny** | **list** <access-list-number> | **access-group**} **Example:** `Router(config)# dialer-list 2 protocol ip permit`	Creates a dialer list for traffic of interest and permits access to an entire protocol.
Step 6	**ip access-list** *<access list number>* **permit** *<ip source address>* **Example:** `Router(config)# access list 2 permit 10.4.0.0`	Defines traffic of interest. Do not use the **access list permit all** command to avoid sending traffic to the IP network. This may result in call termination.
Step 7	**interface cellular** ***0*** **Example:** `Router (config)# interface cellular 0`	Specifies the cellular interface.

Step 8	**dialer string** *<string>*
	
	or
	
	dialer group *<dialer group number>*
	
	Example:
	`Router (config-if)# dialer string cdma  *** cdma ***`
	
	or
	
	`Router (config-if)# dialer group 2  *** gsm ***`
		CDMA only. Specifies the dialer script (defined using the **chat script** command).
		
		GSM only. Maps a dialer list to the dialer interface.

Configuring DDR Backup Using Floating Static Route

To configure a floating static default route on the secondary interface, use the following commands, beginning in the global configuration mode.

Note Make sure you have ip classless enabled on your router.

SUMMARY STEPS

1. **configure terminal**
2. **ip route** *network-number network-mask* {ip address | interface} [administrative distance] [**name** *name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** Router# configure terminal	Enters global configuration mode from the terminal.
Step 2	**ip route** *network-network-mask* {ip-address | interface} [administrative distance] [**name** name] **Example:** Router (config)# ip route 0.0.0.0 Dialer 2 track 234	Establishes a floating static route with the configured administrative distance through the specified interface. A higher administrative distance should be configured for the route through the backup interface, so that the backup interface is used only when the primary interface is down.

Cellular Wireless Modem as Backup with NAT and IPsec Configuration

The following example shows how to configure the 3G wireless modem as backup with NAT and IPsec on either GSM or CDMA networks.

Note The receive and transmit speeds cannot be configured. The actual throughput depends on the cellular network service.

```
Current configuration : 3433 bytes
!
version 12.4
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
```

```
!
!
no aaa new-model
!
!
!
!
crypto isakmp policy 1
 encr 3des
 authentication pre-share
crypto isakmp key gsm address 128.107.241.234
!
!
crypto ipsec transform-set gsm ah-sha-hmac esp-3des
!
crypto map gsm1 10 ipsec-isakmp
 set peer 128.107.241.234
 set transform-set gsm
 match address 103
!
!
!
no ip dhcp use vrf connected
ip dhcp excluded-address 10.4.0.254
!
ip dhcp pool gsmpool
   network 10.4.0.0 255.255.0.0
   dns-server 66.209.10.201 66.102.163.231
   default-router 10.4.0.254
!
!
ip cef
!
no ipv6 cef
multilink bundle-name authenticated
chat-script gsm "" "atdt*98*1#" TIMEOUT 30 "CONNECT"
!
!
archive
 log config
  hidekeys
!
!
interface 0
 no ip address
 ip virtual-reassembly
 load-interval 30
 no ilmi-keepalive
!
interface 0.1 point-to-point
 backup interface Cellular0
 ip nat outside
 ip virtual-reassembly
 pvc 0/35
  pppoe-client dial-pool-number 2
 !
!
interface FastEthernet0
!
interface FastEthernet1
!
interface FastEthernet2
!
interface FastEthernet3
```

```
!
interface Cellular0
 ip address negotiated
 ip nat outside
 ip virtual-reassembly
 encapsulation ppp
 no ip mroute-cache
 dialer in-band
 dialer idle-timeout 0
 dialer string gsm
 dialer-group 1
 async mode interactive
 no ppp lcp fast-start
 ppp chap hostname chunahayev@wwan.ccs
 ppp chap password 0 B7uhestacr
 ppp ipcp dns request
 crypto map gsm1
!
interface Vlan1
 description used as default gateway address for DHCP clients
 ip address 10.4.0.254 255.255.0.0
 ip nat inside
 ip virtual-reassembly
!
interface Dialer2
 ip address negotiated
 ip mtu 1492
 ip nat outside
 ip virtual-reassembly
 encapsulation ppp
 load-interval 30
 dialer pool 2
 dialer-group 2
 ppp authentication chap callin
 ppp chap password 0 cisco
 ppp ipcp dns request
 crypto map gsm1
!
ip local policy route-map track-primary-if
ip forward-protocol nd
ip route 0.0.0.0 0.0.0.0 Dialer2 track 234
ip route 0.0.0.0 0.0.0.0 Cellular0 254
no ip http server
no ip http secure-server
!
!
ip nat inside source route-map nat2cell interface Cellular0 overload
!
ip sla 1
 icmp-echo 209.131.36.158 source-interface Dialer2
 timeout 1000
 frequency 2
ip sla schedule 1 life forever start-time now
access-list 1 permit any
access-list 2 permit 10.4.0.0 0.0.255.255
access-list 3 permit any
access-list 101 permit ip 10.4.0.0 0.0.255.255 any
access-list 102 permit icmp any host 209.131.36.158
access-list 103 permit ip host 166.136.225.89 128.107.0.0 0.0.255.255
access-list 103 permit ip host 75.40.113.246 128.107.0.0 0.0.255.255
dialer-list 1 protocol ip list 1
dialer-list 2 protocol ip permit
!
!
```

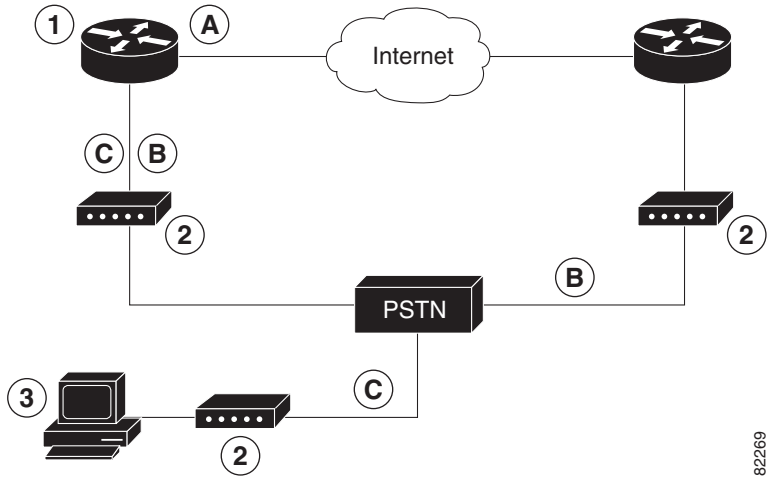
```
!
route-map track-primary-if permit 10
 match ip address 102
 set interface Dialer2
!
route-map nat2cell permit 10
 match ip address 101
 match interface Cellular0
!
!
control-plane
!
!
line con 0
 no modem enable
line aux 0
line 3
 exec-timeout 0 0
 script dialer gsm
 login
 modem InOut
 no exec
line vty 0 4
 login
!
scheduler max-task-time 5000

!
webvpn cef
end
```

Configuring Dial Backup and Remote Management Through the Console Port

When customer premises equipment, such as a Cisco 819 ISR, is connected to an ISP, an IP address is dynamically assigned to the router or the IP address may be assigned by the router peer through the centrally managed function. The dial backup feature can be added to provide a failover route in case the primary line fails. The Cisco 819 ISRs can use the auxiliary port for dial backup and remote management.

Figure 6-1 shows the network configuration used for remote management access and for providing backup to the primary WAN line.

Figure 6-1 Dial Backup and Remote Management Through the Auxiliary Port



1	Cisco 819 router	**A**	Main WAN link; primary connection to Internet service provider
2	Modem	**B**	Dial backup; serves as a failover link for Cisco 819 routers when primary line goes down
3	PC	**C**	Remote management; serves as dial-in access to allow changes or updates to Cisco IOS configurations

To configure dial backup and remote management for these routers, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **ip name-server** *server-address*
2. **ip dhcp pool** *name*
3. **exit**
4. **chat-script** *script-name expect-send*
5. **interface** *type number*
6. **exit**
7. **interface** *type number*
8. **dialer watch-group** *group-number*
9. **exit**
10. **ip nat inside source {list** *access-list-number*}{**interface** *type number* **| pool** *name*} **[overload]**
11. **ip route** *prefix mask* {*ip-address* **|** *interface-type interface-number* [*ip-address*]}
12. **access-list** *access-list-number* **{deny | permit}** *source* [*source-wildcard*]
13. **dialerwatch-list** *group-number* **{ip** *ip-address address-mask* **| delay route-check initial** *seconds*}
14. **line [aux | console | tty | vty]** *line-number* [*ending-line-number*]
15. **modem enable**
16. **exit**
17. **line [aux | console | tty | vty]** *line-number* [*ending-line-number*]
18. **flowcontrol {none | software [lock] [in | out] | hardware [in | out]}**

DETAILED STEPS

	Command	Purpose

Step 1	**ip name-server** *server-address*
	
	Example:
	`Router(config)#ip name-server 192.168.28.12`
	`Router(config)#`
		Enters your ISP DNS IP address.
		
		Tip You may add multiple server addresses if available.

Step 2	**ip dhcp pool** *name*
	
	Example:
	`Router(config)#ip dhcp pool 1`
	`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.
		
		• Configure the DHCP address pool. For sample commands that you can use in DHCP pool configuration mode, see the "Example" section on page 6-13.

Step 3	`exit`
	
	Example:
	`Router(config-dhcp)#exit`
	`Router(config)#`
		Exits config-dhcp mode and enters global configuration mode.

Step 4	**chat-script** *script-name expect-send*
	
	Example:
	`Router(config)# chat-script Dialout ABORT ERROR ABORT BUSY "" "AT" OK "ATDT 5555102 T" TIMEOUT 45 CONNECT \c`
	`Router(config)#`
		Configures a chat script used in dial-on-demand routing (DDR) to give commands for dialing a modem and for logging in to remote systems. The defined script is used to place a call over a modem connected to the PSTN.

Step 5	**interface** *type number*
	
	Example:
	`Router(config)# interface Async 1`
	`Router(config-if)#`
		Creates and enters configuration mode for the asynchronous interface.
		
		Configure the asynchronous interface. For sample commands that you can use in asynchronous interface configuration mode, see the "Example" section on page 6-13.

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

Step 7	**interface** *type number*
	
	Example:
	`Router(config)# interface Dialer 3`
	`Router(config-if)#`
		Creates and enters configuration mode for the dialer interface.

	Command	Purpose

Step 8	**dialer watch-group** *group-number*
	
	Example:
	`Router(config-if)# dialer watch-group 1`
	`Router(config-if)#`
		Specifies the group number for the watch list.

Step 9	`exit`
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits the interface configuration mode.

Step 10	**ip nat inside source** {**list** *access-list-number*} {**interface** *type number* | **pool** *name*} [**overload**] **Example:** `Router(config)# ip nat inside source list 101 interface Dialer 3 overload`	Enables dynamic translation of addresses on the inside interface.

Step 11	**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)#`
		Sets the IP route to point to the dialer interface as a default gateway.

Step 12	**access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*] **Example:** `Router(config)# access-list 1 permit 192.168.0.0 0.0.255.255 any`	Defines an extended access list that indicates which addresses need translation.

Step 13	**dialerwatch-list** *group-number* {**ip** *ip-address address-mask* | **delay route-check initial** *seconds*}
	
	Example:
	`Router(config)# dialer watch-list 1 ip 22.0.0.2 255.255.255.255`
	`Router(config)#`
		Evaluates the status of the primary link, based on the existence of routes to the peer. The address 22.0.0.2 is the peer IP address of the ISP.

Step 14	**line** [**aux** | **console** | **tty** | **vty**] *line-number* [*ending-line-number*]
	
	Example:
	`Router(config)# line console 0`
	`Router(config-line)#`
		Enters configuration mode for the line interface.

	Command	Purpose

Step 15	**modem enable**
	
	Example:
	`Router(config-line)# modem enable`
	`Router(config-line)#`
		Switches the port from console to auxiliary port function.

Step 16	`exit`
	
	Example:
	`Router(config-line)# exit`
	`Router(config)#`
		Exits the configure interface mode.

Step 17	**line** [**aux** | **console** | **tty** | **vty**] *line-number* [*ending-line-number*]
	
	Example:
	`Router(config)# line aux 0`
	`Router(config)#`
		Enters configuration mode for the auxiliary interface.

Step 18	**flowcontrol** {**none** | **software** [**lock**] [**in** | **out**] | **hardware** [**in** | **out**]}
	
	Example:
	`Router(config)# flowcontrol hardware`
	`Router(config)#`
		Enables hardware signal flow control.

Example

The following configuration example specifies an IP address for the interface through PPP and IPCP address negotiation and dial backup over the console port:

```
!
ip name-server 192.168.28.12
ip dhcp excluded-address 192.168.1.1
!
ip dhcp pool 1
 import all
 network 192.168.1.0 255.255.255.0
 default-router 192.168.1.1
!
! Need to use your own correct ISP phone number.
modemcap entry MY-USER_MODEM:MSC=&F1S0=1
chat-script Dialout ABORT ERROR ABORT BUSY "" "AT" OK "ATDT 5555102\T"
TIMEOUT 45 CONNECT \c
!
!
!
!
interface vlan 1
 ip address 192.168.1.1 255.255.255.0
 ip nat inside
 ip tcp adjust-mss 1452
 hold-queue 100 out
!
```

```
! Dial backup and remote management physical interface.
interface Async1
 no ip address
 encapsulation ppp
 dialer in-band
 dialer pool-member 3
 async default routing
 async dynamic routing
 async mode dedicated
 ppp authentication pap callin
!
interface ATM0
 mtu 1492
 no ip address
 no atm ilmi-keepalive
 pvc 0/35
 pppoe-client dial-pool-number 1
!
! Primary WAN link.
interface Dialer1
 ip address negotiated
 ip nat outside
 encapsulation ppp
 dialer pool 1
 ppp authentication pap callin
 ppp pap sent-username account password 7 pass
 ppp ipcp dns request
 ppp ipcp wins request
 ppp ipcp mask request
!
! Dialer backup logical interface.
interface Dialer3
 ip address negotiated
 ip nat outside
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer pool 3
 dialer idle-timeout 60
 dialer string 5555102 modem-script Dialout
 dialer watch-group 1
!
! Remote management PC IP address.
peer default ip address 192.168.2.2
no cdp enable
!
! Need to use your own ISP account and password.
ppp pap sent-username account password 7 pass
ppp ipcp dns request
ppp ipcp wins request
ppp ipcp mask request
!
! IP NAT over Dialer interface using route-map.
ip nat inside source route-map main interface Dialer1 overload
ip nat inside source route-map secondary interface Dialer3 overload
ip classless
!
! When primary link is up again, distance 50 will override 80 if dial backup
! has not timed out. Use multiple routes because peer IP addresses are alternated
! among them when the CPE is connected.
ip route 0.0.0.0 0.0.0.0 64.161.31.254 50
ip route 0.0.0.0 0.0.0.0 66.125.91.254 50
ip route 0.0.0.0 0.0.0.0 64.174.91.254 50
ip route 0.0.0.0 0.0.0.0 63.203.35.136 80
```

```
ip route 0.0.0.0 0.0.0.0 63.203.35.137 80
ip route 0.0.0.0 0.0.0.0 63.203.35.138 80
ip route 0.0.0.0 0.0.0.0 63.203.35.139 80
ip route 0.0.0.0 0.0.0.0 63.203.35.140 80
ip route 0.0.0.0 0.0.0.0 63.203.35.141 80
ip route 0.0.0.0 0.0.0.0 Dialer1 150
no ip http server
ip pim bidir-enable
!
! PC IP address behind CPE.
access-list 101 permit ip 192.168.0.0 0.0.255.255 any
access-list 103 permit ip 192.168.0.0 0.0.255.255 any
!
! Watch multiple IP addresses because peers are alternated
! among them when the CPE is connected.
dialer watch-list 1 ip 64.161.31.254 255.255.255.255
dialer watch-list 1 ip 64.174.91.254 255.255.255.255
dialer watch-list 1 ip 64.125.91.254 255.255.255.255
!
! Dial backup will kick in if primary link is not available
! 5 minutes after CPE starts up.
dialer watch-list 1 delay route-check initial 300
dialer-list 1 protocol ip permit
!
! Direct traffic to an interface only if the dialer is assigned an IP address.
route-map main permit 10
 match ip address 101
 match interface Dialer1
!
route-map secondary permit 10
 match ip address 103
 match interface Dialer3
!
! Change console to aux function.
line con 0
 exec-timedout 0 0
 modem enable
 stopbits 1
line aux 0
 exec-timeout 0 0
 ! To enable and communicate with the external modem properly.
 script dialer Dialout
 modem InOut
 modem autoconfigure discovery
 transport input all
 stopbits 1
 speed 115200
 flowcontrol hardware
line vty 0 4
 exec-timeout 0 0
 password cisco
 login
!
scheduler max-task-time 5000
end
```

CHAPTER 7

Environmental and Power Management

The Cisco 819 integrated services routers are equipped with sensors in the router body for monitoring the environment temperature and logging the temperature every 30 seconds.There are four sensors located on the four corners of the router chassis. There is an additonal System Ambient sensor and a 3G sensor.

The corner sensors display the following message:

- Error message on the console—When the temperature ranges are outside the set temperature thresholds, the monitor displays an error message. Different temperature ranges are set for different SKUs of the router:
  - Cisco 819G (non-hardened): 0 to 60 degrees celcius
  - Cisco 819HG (hardened): –25 to 75 degrees celcius
- SNMP Traps—syslog messages are created when the temperature is outside the specified range.
- Server “call home” feature—The server callhome feature is already enabled to call Cisco TAC in the event of very high or low temperatures.

In addition to the corner sensors, the System Ambient and 3G sensors also log the temperature every 30 seconds onto bootflash memory.

Any time the temperature is above the high threshold, or lower than the low threshold, the temperature information will be saved in non-volatile memory region and is also displayed as part of this output.

Use the **show environment** command to check the temperature of the router. You can also use this command to display the power usage and the power consumption of the unit at the end.

The following is a sample output for the **show environment** command:

```
router# show environment

SYSTEM WATTAGE
===============
 Board Power consumption is: 4.851 W
 Power Supply Loss:  1.149 W
 Total System Power consumption is: 6.000 W


REAL TIME CLOCK BATTERY STATUS
==============================
 Battery OK (checked at power up)

TEMPERATURE STATUS
==================
 Sensor                 Current                        High/Low
 Name                   Temperature    Status          Threshold
 --------------------- -------------- -------------- ---------
```

```
Sensor 1              36            Normal         60/0
Sensor 2              34            Normal         60/0
Sensor 3              40            Normal         60/0
Sensor 4              38            Normal         60/0
System Ambient Sensor 35            Normal         60/0
3G Modem Sensor       33            Normal         85/0

Environmental information last updated 00:00:26 ago
```

Note If the modem temperature goes up to 85 degrees for non-hardened or 90 degrees for hardened version, a warning message appears. The router automatically shuts down if the temperature goes higher than 108 degrees.

Cisco EnergyWise Support

The Cisco 819 ISRs have hardware and software features for reducing power consumption. The hardware features include high-efficiency AC power supplies and electrical components with built-in power saving features, such as RAM select and clock gating. For more information, see *Cisco 819 Integrated Services Router Hardware Installation Guide*.

The software features include Cisco EnergyWise, a power efficiency management feature that powers down unused modules and disable unused clocks to the modules and peripherals on the router.

The Cisco 819 ISRs must be running Cisco IOS Release 15.0(1)M or later to support EnergyWise.

Detailed configuration procedures are included in *Cisco EnergyWise Configuration Guide, EnergyWise Phase 1* and *Cisco EnergyWise Configuration Guide, EnergyWise Phase 2*.

CHAPTER 8

Configuring the Serial Interface

This chapter describes configuring serial interface management in the following sections:

- Legacy Protocol Transport, page 8-2
- Configuring Serial Interfaces, page 8-2
- Information About Configuring Serial Interfaces, page 8-3
- How to Configure Serial Interfaces, page 8-6
- Configuration Examples, page 8-19

The Cisco 819 Integrated Services Router (ISR) supports synchronous by default and asynchronous serial interface protocols.

Configuring the serial interface in the Cisco 819 ISR allows you to enable applications such as WAN access, legacy protocol transport, console server, and dial access server. It also allows remote network management, external dial-modem access, low-density WAN aggregation, legacy protocol transport, and high port-density support.

Serial interfaces enables the following features:

- WAN access and aggregation
- Legacy protocol transport
- Dial access server

Serial interfaces can be used to provide WAN access for remote sites. With support for serial speeds up to 8 Mbps, it is ideal for low- and medium-density WAN aggregation.

Figure 8-1 WAN Concentration

Legacy Protocol Transport

Serial and synchronous/asynchronous ports are ideally suited to transport legacy traffic across a TCP/IP network, facilitating network convergence. Legacy protocols supported by Cisco IOSR Software include:

- Synchronous Data Link Control (SDLC) Protocol
- Binary Synchronous Communications Protocol (Bisync)
- X.25 Protocol

Figure 8-2 Network Convergence

The Cisco 819 ISRs use Cisco Smart Serial connectors. The supported cables are noted in Table 8-1.

Table 8-1 Smart Serial Cabling for Cisco 819 ISRs

Product Number	Cable Type	Length	Connector Type
CAB-SS-V35MT	V.35 DTE	10 ft (3m)	Male
CAB-SS-V35FC 10 ft (3m) Female	V.35 DCE	10 ft (3m)	Female
CAB-SS-232MT	EIA/TIA-232 DTE	10 ft (3m)	Male
CAB-SS-232FC	EIA/TIA-232 DTE	10 ft (3m)	Female
CAB-SS-449MT	EIA/TIA-449 DTE	10 ft (3m)	Male
CAB-SS-449FC	EIA/TIA-449 DTE	10 ft (3m)	Female
CAB-SS-X21MT	X.21 DTE	10 ft (3m)	Male
CAB-SS-X21FC	X.21 DTE	10 ft (3m)	Female
CAB-SS-530MT	EIA/TIA-530 DTE	10 ft (3m)	Male
CAB-SS-530AMT	EIA/TIA-232 DTE	10 ft (3m)	Male

Configuring Serial Interfaces

When the router receives an indication that the primary interface is down, the backup interface becomes enabled. After the primary connection has been restored for a specified period, the backup interface is disabled.

Even if the backup interface comes out of standby mode, the router does not enable the backup interface unless the router receives the traffic specified for that backup interface.

Information About Configuring Serial Interfaces

To configure serial interfaces, you must understand the following concept:

- Cisco HDLC Encapsulation, page 8-3
- PPP Encapsulation, page 8-3
- Keepalive Timer, page 8-4
- Frame Relay Encapsulation, page 8-5

Cisco HDLC Encapsulation

Cisco High-Level Data Link Controller (HDLC) is the Cisco proprietary protocol for sending data over synchronous serial links using HDLC. Cisco HDLC also provides a simple control protocol called Serial Line Address Resolution Protocol (SLARP) to maintain serial link keepalives. Cisco HDLC is the default for data encapsulation at Layer 2 (data link) of the Open System Interconnection (OSI) stack for efficient packet delineation and error control.

Note Cisco HDLC is the default encapsulation type for the serial interfaces.

When the encapsulation on a serial interface is changed from HDLC to any other encapsulation type, the configured serial subinterfaces on the main interface inherit the newly changed encapsulation and they do not get deleted.

Cisco HDLC uses keepalives to monitor the link state, as described in the "Keepalive Timer" section on page 8-4.

PPP Encapsulation

PPP is a standard protocol used to send data over synchronous serial links. PPP also provides a Link Control Protocol (LCP) for negotiating properties of the link. LCP uses echo requests and responses to monitor the continuing availability of the link.

Note When an interface is configured with PPP encapsulation, a link is declared down and full LCP negotiation is re-initiated after five echo request (ECHOREQ) packets are sent without receiving an echo response (ECHOREP).

PPP provides the following Network Control Protocols (NCPs) for negotiating properties of data protocols that will run on the link:

- IP Control Protocol (IPCP) to negotiate IP properties
- Multiprotocol Label Switching control processor (MPLSCP) to negotiate MPLS properties
- Cisco Discovery Protocol control processor (CDPCP) to negotiate CDP properties
- IPv6CP to negotiate IP Version 6 (IPv6) properties
- Open Systems Interconnection control processor (OSICP) to negotiate OSI properties

PPP uses keepalives to monitor the link state, as described in the "Keepalive Timer" section on page 8-4.

PPP supports the following authentication protocols, which require a remote device to prove its identity before allowing data traffic to flow over a connection:

- Challenge Handshake Authentication Protocol (CHAP)—CHAP authentication sends a challenge message to the remote device. The remote device encrypts the challenge value with a shared secret and returns the encrypted value and its name to the local router in a response message. The local router attempts to match the remote device's name with an associated secret stored in the local username or remote security server database; it uses the stored secret to encrypt the original challenge and verify that the encrypted values match.
- Microsoft Challenge Handshake Authentication Protocol (MS-CHAP)—MS-CHAP is the Microsoft version of CHAP. Like the standard version of CHAP, MS-CHAP is used for PPP authentication; in this case, authentication occurs between a personal computer using Microsoft Windows NT or Microsoft Windows 95 and a Cisco router or access server acting as a network access server.
- Password Authentication Protocol (PAP)—PAP authentication requires the remote device to send a name and a password, which are checked against a matching entry in the local username database or in the remote security server database.

Use the **ppp authentication** command in interface configuration mode to enable CHAP, MS-CHAP, and PAP on a serial interface.

Note Enabling or disabling PPP authentication does not effect the local router's willingness to authenticate itself to the remote device.

Multilink PPP

Multilink Point-to-Point Protocol (MLPPP) is supported on the Cisco 819 ISR serial interface. MLPPP provides a method for combining multiple physical links into one logical link. The implementation of MLPPP combines multiple PPP serial interfaces into one multilink interface. MLPPP performs the fragmenting, reassembling, and sequencing of datagrams across multiple PPP links.

MLPPP provides the same features that are supported on PPP Serial interfaces with the exception of QoS. It also provides the following additional features:

- Fragment sizes of 128, 256, and 512 bytes
- Long sequence numbers (24-bit)
- Lost fragment detection timeout period of 80 ms
- Minimum-active-links configuration option
- LCP echo request/reply support over multilink interface
- Full T1 and E1 framed and unframed links

Keepalive Timer

Cisco keepalives are useful for monitoring the link state. Periodic keepalives are sent to and received from the peer at a frequency determined by the value of the keepalive timer. If an acceptable keepalive response is not received from the peer, the link makes the transition to the down state. As soon as an acceptable keepalive response is obtained from the peer or if keepalives are disabled, the link makes the transition to the up state.

Note The **keepalive** command applies to serial interfaces using HDLC or PPP encapsulation. It does not apply to serial interfaces using Frame Relay encapsulation.

For each encapsulation type, a certain number of keepalives ignored by a peer triggers the serial interface to transition to the down state. For HDLC encapsulation, three ignored keepalives causes the interface to be brought down. For PPP encapsulation, five ignored keepalives causes the interface to be brought down. ECHOREQ packets are sent out only when LCP negotiation is complete (for example, when LCP is open).

Use the **keepalive** command in interface configuration mode to set the frequency at which LCP sends ECHOREQ packets to its peer. To restore the system to the default keepalive interval of 10 seconds, use the **keepalive** command with the **no** keyword. To disable keepalives, use the **keepalive disable** command. For both PPP and Cisco HDLC, a keepalive of 0 disables keepalives and is reported in the **show running-config** command output as **keepalive disable**.

When LCP is running on the peer and receives an ECHOREQ packet, it responds with an ECHOREP packet, regardless of whether keepalives are enabled on the peer.

Keepalives are independent between the two peers. One peer end can have keepalives enabled; the other end can have them disabled. Even if keepalives are disabled locally, LCP still responds with ECHOREP packets to the ECHOREQ packets it receives. Similarly, LCP also works if the period of keepalives at each end is different.

Frame Relay Encapsulation

When Frame Relay encapsulation is enabled on a serial interface, the interface configuration is hierarchical and comprises the following elements:

- The serial main interface comprises the physical interface and port. If you are not using the serial interface to support Cisco HDLC and PPP encapsulated connections, then you must configure subinterfaces with permanent virtual circuits (PVCs) under the serial main interface. Frame Relay connections are supported on PVCs only.
- Serial subinterfaces are configured under the serial main interface. A serial subinterface does not actively carry traffic until you configure a PVC under the serial subinterface. Layer 3 configuration typically takes place on the subinterface.
- When the encapsulation on a serial interface is changed from HDLC to any other encapsulation type, the configured serial subinterfaces on the main interface inherit the newly changed encapsulation and they do not get deleted.
- Point-to-point PVCs are configured under a serial subinterface. You cannot configure a PVC directly under a main interface. A single point-to-point PVC is allowed per subinterface. PVCs use a predefined circuit path and fail if the path is interrupted. PVCs remain active until the circuit is removed from either configuration. Connections on the serial PVC support Frame Relay encapsulation only.

Note The administrative state of a parent interface drives the state of the subinterface and its PVC. When the administrative state of a parent interface or subinterface changes, so does the administrative state of any child PVC configured under that parent interface or subinterface.

To configure Frame Relay encapsulation on serial interfaces, use the **encapsulation (Frame Relay VC-bundle)** command.

Frame Relay interfaces support two types of encapsulated frames:

- Cisco (default)
- IETF

Use the **encap** command in PVC configuration mode to configure Cisco or IETF encapsulation on a PVC. If the encapsulation type is not configured explicitly for a PVC, then that PVC inherits the encapsulation type from the main serial interface.

Note Cisco encapsulation is required on serial main interfaces that are configured for MPLS. IETF encapsulation is not supported for MPLS.

Before you configure Frame Relay encapsulation on an interface, you must verify that all prior Layer 3 configuration is removed from that interface. For example, you must ensure that there is no IP address configured directly under the main interface; otherwise, any Frame Relay configuration done under the main interface will not be viable.

LMI on Frame Relay Interfaces

The Local Management Interface (LMI) protocol monitors the addition, deletion, and status of PVCs. LMI also verifies the integrity of the link that forms a Frame Relay UNI interface. By default, **cisco** LMI is enabled on all PVCs.

If the LMI type is **cisco** (the default LMI type), the maximum number of PVCs that can be supported under a single interface is related to the MTU size of the main interface. Use the following formula to calculate the maximum number of PVCs supported on a card or SPA:

```
(MTU - 13)/8 = maximum number of PVCs
```

Note The default setting of the **mtu** command for a serial interface is 1504 bytes. Therefore, the default numbers of PVCs supported on a serial interface configured with **cisco** LMI is 186.

How to Configure Serial Interfaces

This section contains the following tasks:

- Configuring a Synchronous Serial Interface, page 8-6
- Configuring Low-Speed Serial Interfaces, page 8-14

Configuring a Synchronous Serial Interface

Synchronous serial interfaces are supported on various serial network interface cards or systems. This interface supports full-duplex operation at T1 (1.544 Mbps) and E1 (2.048 Mbps) speeds.

To configure a synchronous serial interface, perform the tasks in the following sections. Each task in the list is identified as either required or optional.

- Specifying a Synchronous Serial Interface, page 8-7 (Required)
- Specifying Synchronous Serial Encapsulation, page 8-7 (Optional)
- Configuring PPP, page 8-8 (Optional)

- Configuring Half-Duplex and Bisync for Synchronous Serial Port Adapters on Cisco 819 ISRs, page 8-8 (Optional)
- Configuring Compression of HDLC Data, page 8-9 (Optional)
- Using the NRZI Line-Coding Format, page 8-9 (Optional)
- Enabling the Internal Clock, page 8-10 (Optional)
- Inverting the Transmit Clock Signal, page 8-10 (Optional)
- Setting Transmit Delay, page 8-11 (Optional)
- Configuring DTR Signal Pulsing, page 8-11 (Optional)
- Ignoring DCD and Monitoring DSR as Line Up/Down Indicator, page 8-11 (Optional)
- Specifying the Serial Network Interface Module Timing, page 8-12 (Optional)

See the "Configuration Examples" section on page 8-19 for examples of configuration tasks described in this chapter.

Specifying a Synchronous Serial Interface

To specify a synchronous serial interface and enter interface configuration mode, use one of the following commands in global configuration mode.

Command	Purpose
`Router(config)# interface serial 0`	Enters interface configuration mode.

Specifying Synchronous Serial Encapsulation

By default, synchronous serial lines use the High-Level Data Link Control (HDLC) serial encapsulation method, which provides the synchronous framing and error detection functions of HDLC without windowing or retransmission. The synchronous serial interfaces support the following serial encapsulation methods:

- HDLC
- Frame Relay
- PPP
- Synchronous Data Link Control (SDLC)
- SMDS
- Cisco Serial Tunnel (STUN)
- Cisco Bisync Serial Tunnel (BSTUN)
- X.25-based encapsulations

To define the encapsulation method, use the following command in interface configuration mode.

Command	Purpose
`Router(config-if)# encapsulation {hdlc | frame-relay | ppp | sdlc-primary | sdlc-secondary | smds | stun | x25 | bstun}`	Configures synchronous serial encapsulation.

Note You cannot use the **physical-layer async** command for frame-relay encapsulation.

Encapsulation methods are set according to the type of protocol or application you configure in the Cisco IOS software.

- PPP is described in *Configuring Media-Independent PPP and Multilink PPP*.
- The remaining encapsulation methods are defined in their respective books and chapters describing the protocols or applications. Serial encapsulation methods are also discussed in the *Cisco IOS Interface and Hardware Component Command Reference*, under the **encapsulation** command.

By default, synchronous interfaces operate in full-duplex mode. To configure an SDLC interface for half-duplex mode, use the following command in interface configuration mode.

Command	Purpose
`Router(config-if)# half-duplex`	Configures an SDLC interface for half-duplex mode.

Binary synchronous communication (Bisync) is a half-duplex protocol. Each block of transmission is acknowledged explicitly. To avoid the problem associated with simultaneous transmission, there is an implicit role of primary and secondary stations. The primary sends the last block again if there is no response from the secondary within the period of block receive timeout.

To configure the serial interface for full-duplex mode, use the following command in interface configuration mode.

Command	Purpose
`Router(config-if)# full-duplex`	Specifies that the interface can run Bisync using switched RTS signals.

Configuring PPP

To configure PPP, refer to the *Configuring Media-Independent PPP and Multilink PPP*.

Configuring Half-Duplex and Bisync for Synchronous Serial Port Adapters on Cisco 819 ISRs

The synchronous serial port adapters on Cisco 819 ISRs support half-duplex and Bisync. Bisync is a character-oriented data-link layer protocol for half-duplex applications. In half-duplex mode, data is sent one direction at a time. Direction is controlled by handshaking the Request to Send (RST) and Clear to Send (CTS) control lines. These are described in the "Configuring Bisync" section on page 8-8.

Configuring Bisync

To configure the Bisync feature on the synchronous serial port adapters on Cisco 819 ISRs, refer to the *Block Serial Tunneling (BSTUN) Overview*. All commands listed in this section apply to the synchronous serial port adapters on Cisco 891 ISRs. Any command syntax that specifies an interface *number* supports the Cisco 891 ISRs **slot/port** syntax.

Configuring Compression of HDLC Data

You can configure point-to-point software compression on serial interfaces that use HDLC encapsulation. Compression reduces the size of a HDLC frame via lossless data compression. The compression algorithm used is a Stacker (LZS) algorithm.

Compression is performed in software and might significantly affect system performance. We recommend that you disable compression if CPU load exceeds 65 percent. To display the CPU load, use the **show process cpu** EXEC command.

If the majority of your traffic is already compressed files, you should not use compression.

To configure compression over HDLC, use the following commands in interface configuration mode.

SUMMARY STEPS

1. **encapsulation hdlc**
2. **compress stac**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`encapsulation hdlc`** **Example:** `Router(config-if)# encapsulation hdlc`	Enables encapsulation of a single protocol on the serial line.
Step 2	**`compress stac`** **Example:** `Router(config-if)# compress stac`	Enables compression.

Using the NRZI Line-Coding Format

The nonreturn-to-zero (NRZ) and nonreturn-to-zero inverted (NRZI) formats are supported on the Cisco 819 serial ports.

NRZ and NRZI are line-coding formats that are required for serial connections in some environments. NRZ encoding is most common. NRZI encoding is used primarily with EIA/TIA-232 connections in IBM environments.

The default configuration for all serial interfaces is NRZ format. The default is **no nrzi-encoding**.

To enable NRZI format, use one of the following commands in interface configuration mode.

SUMMARY STEPS

1. **nrzi-encoding**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**`nrzi-encoding`**
	
	Example:
	`Router(config-if)# nrzi-encoding`
	`or`
	`Router(config-if)# nrzi-encoding [mark]`
		Enables NRZI encoding format.
		
		Enables NRZI encoding format for router.

Enabling the Internal Clock

When a DTE does not return a transmit clock, use the following interface configuration command on the router to enable the internally generated clock on a serial interface:

SUMMARY STEPS

1. **transmit-clock-internal**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`transmit-clock-internal`** **Example:** `Router(config-if)# transmit-clock-internal`	Enables the internally generated clock on a serial interface.

Inverting the Transmit Clock Signal

Systems that use long cables or cables that are not transmitting the TxC signal (transmit echoed clock line, also known as TXCE or SCTE clock) can experience high error rates when operating at the higher transmission speeds. For example, if the interface on the PA-8T and PA-4T+ synchronous serial port adapters is reporting a high number of error packets, a phase shift might be the problem. Inverting the clock signal can correct this shift. To invert the clock signal, use the following commands in interface configuration mode.

SUMMARY STEPS

1. **invert txclock**
2. **invert rxclock**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`invert txclock`** **Example:** `Router(config-if)# invert txclock`	Inverts the clock signal on an interface.
Step 2	**`invert rxclock`** **Example:** `Router(config-if)# invert rxclock`	Inverts the phase of the RX clock on the UIO serial interface, which does not use the T1/E1 interface.

Setting Transmit Delay

It is possible to send back-to-back data packets over serial interfaces faster than some hosts can receive them. You can specify a minimum dead time after transmitting a packet to remove this condition. This setting is available for serial interfaces on the MCI and SCI interface cards and for the HSSI or MIP. Use one of the following commands, as appropriate for your system, in interface configuration mode.

Command	Purpose
`Router(config-if)#` **`transmitter-delay`** *`microseconds`*	Sets the transmit delay on the MCI and SCI synchronous serial interfaces.
`Router(config-if)#` **`transmitter-delay`** *`hdlc-flags`*	Sets the transmit delay on the HSSI or MIP.

Configuring DTR Signal Pulsing

You can configure pulsing Data Terminal Ready (DTR) signals on all serial interfaces. When the serial line protocol goes down (for example, because of loss of synchronization), the interface hardware is reset and the DTR signal is held inactive for at least the specified interval. This function is useful for handling encrypting or other similar devices that use the toggling of the DTR signal to reset synchronization. To configure DTR signal pulsing, use the following command in interface configuration mode.

Command	Purpose
`Router(config-if)#` **`pulse-time`** *`seconds`*	Configures DTR signal pulsing.

Ignoring DCD and Monitoring DSR as Line Up/Down Indicator

By default, when the serial interface is operating in DTE mode, it monitors the Data Carrier Detect (DCD) signal as the line up/down indicator. By default, the attached DCE device sends the DCD signal. When the DTE interface detects the DCD signal, it changes the state of the interface to up.

In some configurations, such as an SDLC multidrop environment, the DCE device sends the Data Set Ready (DSR) signal instead of the DCD signal, which prevents the interface from coming up. To tell the interface to monitor the DSR signal instead of the DCD signal as the line up/down indicator, use the following command in interface configuration mode.

SUMMARY STEPS

1. **ignore-dcd**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`ignore-dcd`** **Example:** `Router(config-if)# ignore-dcd`	Configures the serial interface to monitor the DSR signal as the line up/down indicator.

Caution Unless you know for certain that you really need this feature, be very careful using this command. It will hide the real status of the interface. The interface could actually be down and you will not know just by looking at show displays.

Specifying the Serial Network Interface Module Timing

On Cisco 819 ISRs, you can specify the serial Network Interface Module timing signal configuration. When the board is operating as a DCE and the DTE provides terminal timing (SCTE or TT), you can configure the DCE to use SCTE from the DTE. When running the line at high speeds and long distances, this strategy prevents phase shifting of the data with respect to the clock.

To configure the DCE to use SCTE from the DTE, use the following command in interface configuration mode.

SUMMARY STEPS

1. **dce-terminal-timing enable**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`dce-terminal-timing enable`** **Example:** `Router(config-if)# dce-terminal-timing enable`	Configures the DCE to use SCTE from the DTE.

When the board is operating as a DTE, you can invert the TXC clock signal it gets from the DCE that the DTE uses to transmit data. Invert the clock signal if the DCE cannot receive SCTE from the DTE, the data is running at high speeds, and the transmission line is long. Again, this prevents phase shifting of the data with respect to the clock.

To configure the interface so that the router inverts the TXC clock signal, use the following command in interface configuration mode.

SUMMARY STEPS

1. **dte-invert-txc**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**`dte-invert-txc`** **Example:** `Router(config-if)# dte-invert-txc`	Specifies timing configuration to invert TXC clock signal.

Configuring Low-Speed Serial Interfaces

This section describes how to configure low-speed serial interfaces and contains the following sections:

- Understanding Half-Duplex DTE and DCE State Machines, page 8-14
- Changing Between Synchronous and Asynchronous Modes, page 8-18

For configuration examples, see the "Low-Speed Serial Interface: Examples" section on page 8-20.

Understanding Half-Duplex DTE and DCE State Machines

The following sections describe the communication between half-duplex DTE transmit and receive state machines and half-duplex DCE transmit and receive state machines.

Half-Duplex DTE State Machines

As shown in Figure 3, the half-duplex DTE transmit state machine for low-speed interfaces remains in the ready state when it is quiescent. When a frame is available for transmission, the state machine enters the transmit delay state and waits for a time period, which is defined by the **half-duplex timer transmit-delay** command. The default is 0 milliseconds. Transmission delays are used for debugging half-duplex links and assisting lower-speed receivers that cannot process back-to-back frames.

Figure 3 Half-Duplex DTE Transmit State Machine

After idling for a defined number of milliseconds (ms), the state machine asserts a request to send (RTS) signal and changes to the wait-clear-to-send (CTS) state for the DCE to assert CTS. A timeout timer with a value set by the **half-duplex timer rts-timeout** command starts. The default is 3 ms. If the timeout timer expires before CTS is asserted, the state machine returns to the ready state and deasserts RTS. If CTS is asserted before the timer expires, the state machine enters the transmit state and sends the frames.

Once there are no more frames to transmit, the state machine transitions to the wait transmit finish state. The machine waits for the transmit FIFO in the serial controller to empty, starts a delay timer with a value defined by the **half-duplex timer rts-drop-delay** interface command, and transitions to the wait RTS drop delay state.

When the timer in the wait RTS drop delay state expires, the state machine deasserts RTS and transitions to the wait CTS drop state. A timeout timer with a value set by the **half-duplex timer cts-drop-timeout** interface command starts, and the state machine waits for the CTS to deassert. The default is 250 ms. Once the CTS signal is deasserted or the timeout timer expires, the state machine transitions back to the ready state. If the timer expires before CTS is deasserted, an error counter is incremented, which can be displayed by issuing the **show controllers** command for the serial interface in question.

As shown in Figure 4, a half-duplex DTE receive state machine for low-speed interfaces idles and receives frames in the ready state. A giant frame is any frame whose size exceeds the maximum transmission unit (MTU). If the beginning of a giant frame is received, the state machine transitions to the in giant state and discards frame fragments until it receives the end of the giant frame. At this point, the state machine transitions back to the ready state and waits for the next frame to arrive.

Figure 4 Half-Duplex DTE Receive State Machine

An error counter is incremented upon receipt of the giant frames. To view the error counter, use the **show interfaces** command for the serial interface in question.

Half-Duplex DCE State Machines

As shown in Figure 5, for a low-speed serial interface in DCE mode, the half-duplex DCE transmit state machine idles in the ready state when it is quiescent. When a frame is available for transmission on the serial interface, such as when the output queues are no longer empty, the state machine starts a timer (based on the value of the **half-duplex timer transmit-delay** command, in milliseconds) and transitions to the transmit delay state. Similar to the DTE transmit state machine, the transmit delay state gives you the option of setting a delay between the transmission of frames; for example, this feature lets you compensate for a slow receiver that loses data when multiple frames are received in quick succession. The default **transmit-delay** value is 0 ms; use the **half-duplex timer transmit-delay** interface configuration command to specify a delay value not equal to 0.

Figure 5 Half-Duplex DCE Transmit State Machine

After the transmit delay state, the next state depends on whether the interface is in constant-carrier mode (the default) or controlled-carrier mode.

If the interface is in constant-carrier mode, it passes through the following states:

1. The state machine passes to the transmit state when the **transmit-delay** timer expires. The state machine stays in the transmit state until there are no more frames to transmit.
2. When there are no more frames to transmit, the state machine passes to the wait transmit finish state, where it waits for the transmit FIFO to empty.
3. Once the FIFO empties, the DCE passes back to the ready state and waits for the next frame to appear in the output queue.

If the interface is in controlled-carrier mode, the interface performs a handshake using the data carrier detect (DCD) signal. In this mode, DCD is deasserted when the interface is idle and has nothing to transmit. The transmit state machine transitions through the states as follows:

1. After the **transmit-delay** timer expires, the DCE asserts DCD and transitions to the DCD-txstart delay state to ensure a time delay between the assertion of DCD and the start of transmission. A timer is started based on the value specified using the **dcd-txstart-delay** command. (This timer has a default value of 100 ms; use the **half-duplex timer dcd-txstart-delay** interface configuration command to specify a delay value.)
2. When this delay timer expires, the state machine transitions to the transmit state and transmits frames until there are no more frames to transmit.
3. After the DCE transmits the last frame, it transitions to the wait transmit finish state, where it waits for transmit FIFO to empty and the last frame to transmit to the wire. Then DCE starts a delay timer by specifying the value using the **dcd-drop-delay** command. (This timer has the default value of 100 ms; use the **half-duplex timer dcd-drop-delay** interface configuration command to specify a delay value.)

4. The DCE transitions to the wait DCD drop delay state. This state causes a time delay between the transmission of the last frame and the deassertion of DCD in the controlled-carrier mode for DCE transmits.
5. When the timer expires, the DCE deasserts DCD and transitions back to the ready state and stays there until there is a frame to transmit on that interface.

As shown in Figure 6, the half-duplex DCE receive state machine idles in the ready state when it is quiescent. It transitions out of this state when the DTE asserts RTS. In response, the DCE starts a timer based on the value specified using the **cts-delay** command. This timer delays the assertion of CTS because some DTE interfaces expect this delay. (The default value of this timer is 0 ms; use the **half-duplex timer cts-delay** interface configuration command to specify a delay value.)

Figure 6 Half-Duplex DCE Receive State Machine

When the timer expires, the DCE state machine asserts CTS and transitions to the receive state. It stays in the receive state until there is a frame to receive. If the beginning of a giant frame is received, it transitions to the in giant state and keeps discarding all the fragments of the giant frame and transitions back to the receive state.

Transitions back to the ready state occur when RTS is deasserted by the DTE. The response of the DCE to the deassertion of RTS is to deassert CTS and go back to the ready state.

Placing a Low-Speed Serial Interface in Constant-Carrier Mode

To return a low-speed serial interface to constant-carrier mode from controlled-carrier mode, use the following command in interface configuration mode.

SUMMARY STEPS

1. **no half-duplex controlled-carrier**

DETAILED STEPS

	Command or Action	Purpose

Step 1	`no half-duplex controlled-carrier`
	
	Example:
	`Router(config-if)# no half-duplex controlled-carrier`
		Places a low-speed serial interface in constant-carrier mode.

Tuning Half-Duplex Timers

To optimize the performance of half-duplex timers, use the following command in interface configuration mode.

Command	Purpose
`Router(config-if)# half-duplex timer {cts-delay value | cts-drop-timeout value | dcd-drop-delay value | dcd-txstart-delay value | rts-drop-delay value | rts-timeout value | transmit-delay value}`	Tunes half-duplex timers.

The timer tuning commands permit you to adjust the timing of the half-duplex state machines to suit the particular needs of their half-duplex installation.

Note that the **half-duplex timer** command and its options replaces the following two timer tuning commands that are available only on high-speed serial interfaces:

- **sdlc cts-delay**
- **sdlc rts-timeout**

Changing Between Synchronous and Asynchronous Modes

To specify the mode of a low-speed serial interface as either synchronous or asynchronous, use the following command in interface configuration mode.

SUMMARY STEPS

1. **physical-layer** {**sync** | **async**}

DETAILED STEPS

	Command or Action	Purpose

Step 1	`physical-layer {sync | async}`
	
	Example:
	`Router(config-if)# physical-layer sync`
		Specifies the mode of a low-speed interface as either synchronous or asynchronous.

This command applies only to low-speed serial interfaces available on Cisco 2520 through Cisco 2523 routers.

Note When you make a transition from asynchronous mode to synchronous mode in serial interfaces, the interface state becomes down by default. You should then use the **no shutdown** option to bring the interface up.

In synchronous mode, low-speed serial interfaces support all interface configuration commands available for high-speed serial interfaces, except the following two commands:

- **sdlc cts-delay**
- **sdlc rts-timeout**

When placed in asynchronous mode, low-speed serial interfaces support all commands available for standard asynchronous interfaces. The default is synchronous mode.

Note When you use this command, it does not appear in the output of the **show running-config** and **show startup-config** commands because the command is a physical-layer command.

To return to the default mode (synchronous) of a low-speed serial interface on a Cisco 2520 through Cisco 2523 router, use the following command in interface configuration mode.

SUMMARY STEPS

1. **no physical-layer**

DETAILED STEPS

	Command or Action	Purpose

Step 1	`no physical-layer`
	
	Example:
	`Router(config-if)# no physical-layer`
		Returns the interface to its default mode, which is synchronous.

Configuration Examples

Interface Enablement Configuration: Examples

The following example illustrates how to begin interface configuration on a serial interface. It assigns PPP encapsulation to serial interface 0.

```
interface serial 0
 encapsulation ppp
```

The same example on the router, assigning PPP encapsulation to port 0 in slot 1, requires the following commands:

```
interface serial 1/0
 encapsulation ppp
```

The following example shows how to configure the access server so that it will use the default address pool on all interfaces except interface 7, on which it will use an address pool called lass:

```
ip address-pool local
ip local-pool lass 172.30.0.1
 async interface
 interface 7
 peer default ip address lass
```

Low-Speed Serial Interface: Examples

The section includes the following configuration examples for low-speed serial interfaces:

- Synchronous or Asynchronous Mode: Examples, page 8-20
- Half-Duplex Timers: Example, page 8-20

Synchronous or Asynchronous Mode: Examples

The following example shows how to change a low-speed serial interface from synchronous to asynchronous mode:

```
interface serial 2
 physical-layer async
```

The following examples show how to change a low-speed serial interface from asynchronous mode back to its default synchronous mode:

```
interface serial 2
 physical-layer sync
```

or

```
interface serial 2
 no physical-layer
```

The following example shows some typical asynchronous interface configuration commands:

```
interface serial 2
 physical-layer async
 ip address 10.0.0.2 255.0.0.0
 async default ip address 10.0.0.1
 async mode dedicated
 async default routing
```

The following example shows some typical synchronous serial interface configuration commands available when the interface is in synchronous mode:

```
interface serial 2
 physical-layer sync
 ip address 10.0.0.2 255.0.0.0
 no keepalive
 ignore-dcd
 nrzi-encoding
 no shutdown
```

Half-Duplex Timers: Example

The following example shows how to set the cts-delay timer to 1234 ms and the transmit-delay timer to 50 ms:

```
interface serial 2
 half-duplex timer cts-delay 1234
 half-duplex timer transmit-delay 50
```

CHAPTER 9

Configuring Security Features

This chapter provides an overview of authentication, authorization, and accounting (AAA), which is the primary Cisco framework for implementing selected security features that can be configured on the Cisco 819 Integrated Services Routers (ISRs).

This chapter contains the following sections:

- Authentication, Authorization, and Accounting, page 9-1
- Configuring AutoSecure, page 9-2
- Configuring Access Lists, page 9-2
- Configuring Cisco IOS Firewall, page 9-3
- Configuring Cisco IOS IPS, page 9-4
- URL Filtering, page 9-4
- Configuring VPN, page 9-4

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 *Securing User Services Configuration Guide Library, Cisco IOS Release 12.4T*.

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 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.

For more complete information on creating access lists, see *Security Configuration Guide: Access Control Lists, Cisco IOS Release 12.4T*.

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 9-1 lists the commands used to configure access lists.

Table 9-1 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* **deny** {*source* | *source-wildcard* | **any**}
Extended	**ip access-list extended** *name* **{permit | deny}** *protocol* {*source-addr*[*source-mask*] | **any**}{*destination-addr* [*destination-mask*] | **any**}

To create, refine, and manage access lists, see *Security Configuration Guide: Access Control Lists, Cisco IOS Release 12.4T.*

Access Groups

An access group is a sequence of access list definitions bound together with a common name or number. An access group is enabled for an interface during interface configuration. 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 information on configuring and managing access groups, see *Securing the Data Plane Configuration Guide Library, Cisco IOS Release 12.4*.

Configuring Cisco IOS Firewall

The Cisco IOS Firewall lets you configure a stateful firewall where packets are inspected internally and the state of network connections is monitored. Stateful firewall is superior to static access lists because access lists can only permit or deny traffic based on individual packets, not based on streams of packets. Also, because Cisco IOS Firewall inspects the packets, decisions to permit or deny traffic can be made by examining application layer data, which static access lists cannot examine.

To configure a Cisco IOS 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.

For additional information about configuring a Cisco IOS Firewall, see *Securing the Data Plane Configuration Guide Library, Cisco IOS Release 12.4*.

The Cisco IOS Firewall may also be configured to provide voice security in Session Initiated Protocol (SIP) applications. SIP inspection provides basic inspect functionality (SIP packet inspection and detection of pin-hole openings), as well as protocol conformance and application security. For more information, see *Cisco IOS Firewall: SIP Enhancements: ALG and AIC*.

Configuring Cisco IOS IPS

Cisco IOS Intrusion Prevention System (IPS) technology is available on Cisco 819 ISRs and enhances perimeter firewall protection by taking appropriate action on packets and flows that violate the security policy or represent malicious network activity.

Cisco IOS IPS identifies attacks using "signatures" to detect patterns of misuse in network traffic. Cisco IOS IPS acts as an in-line intrusion detection sensor, watching packets and sessions as they flow through the router, scanning each to match known IPS signatures. When Cisco IOS IPS detects suspicious activity, it responds before network security can be compromised, it logs the event, and, depending on configuration, it does one of the following:

- Sends an alarm
- Drops suspicious packets
- Resets the connection
- Denies traffic from the source IP address of the attacker for a specified amount of time
- Denies traffic on the connection for which the signature was seen for a specified amount of time

For additional information about configuring Cisco IOS IPS, see *Securing the Data Plane Configuration Guide Library, Cisco IOS Release 12.4*.

URL Filtering

Cisco 819 ISRs provide category based URL filtering. The user provisions URL filtering on the ISR by selecting categories of websites to be permitted or blocked. An external server, maintained by a third party, will be used to check for URLs in each category. Permit and deny policies are maintained on the ISR. The service is subscription based, and the URLs in each category are maintained by the third-party vendor.

For additional information about configuring URL filtering, see *Subscription-based Cisco IOS Content Filtering*.

Configuring VPN

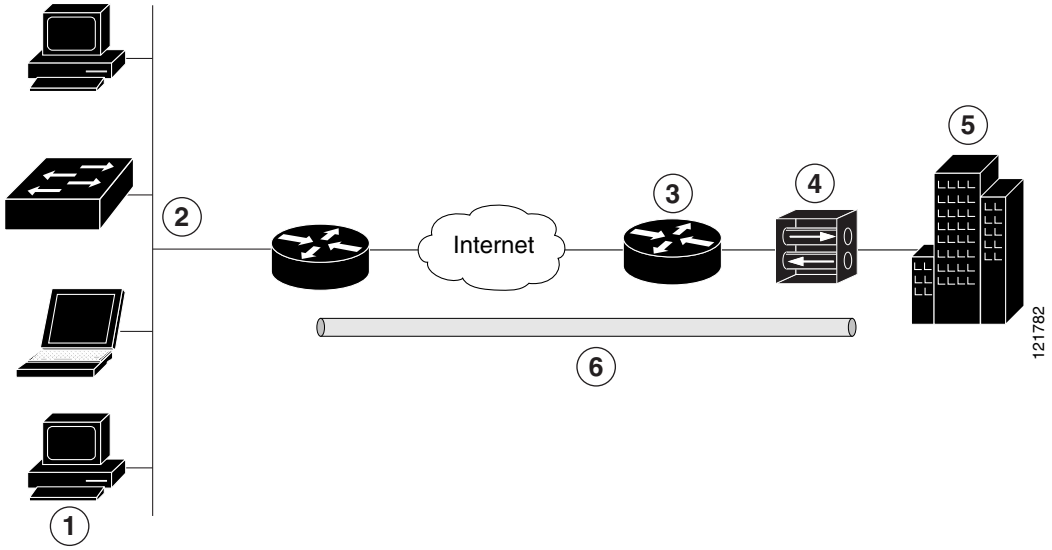
A virtual private network (VPN) connection provides a secure connection between two networks over a public network such as the Internet. Cisco 819 ISRs support two types of VPNs-site-to-site and remote access. Site-to-site VPNs are used to connect branch offices to corporate offices, for example. Remote access VPNs are used by remote clients to log in to a corporate network. Two examples are given in this section: remote access VPN and site-to-site VPN.

- Remote Access VPN, page 9-5
- Site-to-Site VPN, page 9-6
- Configuration Examples, page 9-7
- Configure a VPN over an IPSec Tunnel, page 9-7
- Create a Cisco Easy VPN Remote Configuration, page 9-15
- Configure a Site-to-Site GRE Tunnel, page 9-17

Remote Access VPN

The configuration of a remote access VPN uses Cisco Easy VPN and an IP Security (IPSec) tunnel to configure and secure the connection between the remote client and the corporate network. Figure 9-1 shows a typical deployment scenario.

Figure 9-1 Remote Access VPN Using IPSec Tunnel



1	Remote networked users
2	VPN client—Cisco 819 access 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 210.110.101.1
5	Corporate office with a network address of 10.1.1.1
6	IPSec tunnel

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, Windows Internet Naming Service (WINS) server addresses, and split-tunneling flags, to be defined at a VPN server, such as a Cisco VPN 3000 concentrator that is acting as an IPSec server.

A Cisco 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. Cisco Easy VPN server-enabled devices allow remote routers to act as Cisco 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 819 ISR. 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.

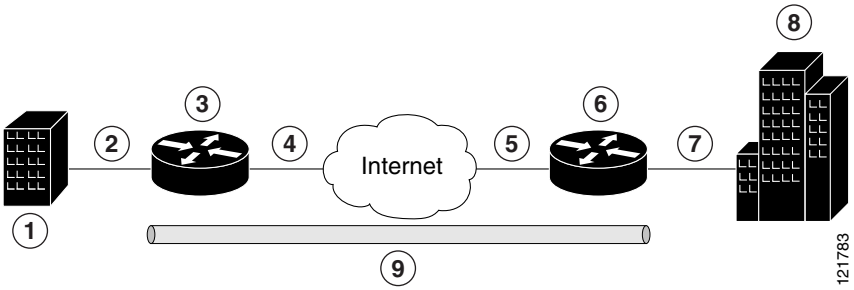
Note The Cisco Easy VPN client feature supports configuration of only one destination peer. If your application requires the creation of multiple VPN tunnels, you must manually configure the IPSec VPN and Network Address Translation/Peer Address Translation (NAT/PAT) parameters on both the client and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

Cisco 819 ISRs can be also configured to act as Cisco Easy VPN servers, letting authorized Cisco Easy VPN clients establish dynamic VPN tunnels to the connected network. For information on the configuration of Cisco Easy VPN servers, see the *Easy VPN Server* feature document.

Site-to-Site VPN

The configuration of a site-to-site VPN uses IPSec and the generic routing encapsulation (GRE) protocol to secure the connection between the branch office and the corporate network. Figure 9-2 shows a typical deployment scenario.

Figure 9-2 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 819 ISR
4	Fast Ethernet —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

For more information about IPSec and GRE configuration, see *Secure Connectivity Configuration Guide Library, Cisco IOS Release 12.4T*.

Configuration Examples

Each example configures a VPN over an IPSec tunnel, using the procedure given in the "Configure a VPN over an IPSec Tunnel" section on page 9-7. Then, the specific procedure for a remote access configuration is given, followed by the specific procedure for a site-to-site configuration.

The examples shown in this chapter apply only to the endpoint configuration on the Cisco 819 ISRs. Any VPN connection requires both endpoints to be configured properly to function. See the software configuration documentation as needed to configure VPN for other router models.

VPN configuration information must be configured on both endpoints. You must specify parameters, such as internal IP addresses, internal subnet masks, DHCP server addresses, and Network Address Translation (NAT).

Configure a VPN over an IPSec Tunnel

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

- Configure the IKE Policy, page 9-7
- Configure Group Policy Information, page 9-9
- Apply Mode Configuration to the Crypto Map, page 9-10
- Enable Policy Lookup, page 9-11
- Configure IPSec Transforms and Protocols, page 9-12
- Configure the IPSec Crypto Method and Parameters, page 9-12
- Apply the Crypto Map to the Physical Interface, page 9-14
- Where to Go Next, page 9-14

Configure the IKE Policy

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

SUMMARY STEPS

1. **crypto isakmp policy** *priority*
2. **encryption** {**des** | **3des** | **aes** | **aes 192** | **aes 256**}
3. **hash** {**md5** | **sha**}
4. **authentication** {**rsa-sig** | **rsa-encr** | **pre-share**}
5. **group** {**1** | **2** | **5**}
6. **lifetime** *seconds*
7. **exit**

DETAILED STEPS

	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.

Step 6	**lifetime** *seconds*
	
	Example:
	`Router(config-isakmp)# lifetime 480`
	`Router(config-isakmp)#`
		Specifies the lifetime, from 60 to 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

To configure the group policy, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **crypto isakmp client configuration group** {**group-name** | **default**}
2. **key** *name*
3. **dns** *primary-server*
4. **domain** *name*
5. **exit**
6. **ip local pool** {**default** | *poolname*} [*low-ip-address* [*high-ip-address*]]

DETAILED STEPS

	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.
		
		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** | *pool name*} [*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 *Cisco IOS Dial Technologies Command Reference*.

Apply Mode Configuration to the Crypto Map

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

SUMMARY STEPS

1. **crypto map** *map-name* **isakmp authorization list** *list-name*
2. **crypto map** *tag* **client configuration address** [**initiate** | **respond**]

DETAILED STEPS

	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

To enable policy lookup through AAA, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **aaa new-model**
2. **aaa authentication login** {**default** | *list-name*} *method1* [*method2*...]
3. **aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2*...]]
4. **username** *name* {**no password** | **password** *password* | **password** *encryption-type encrypted-password*}

DETAILED STEPS

	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*} *method 1* [*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 *Securing User Services Configuration Guide Library, Cisco IOS Release 12.4T* and *Cisco IOS Security Command Reference*.

Step 3	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method 1* [*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 *Securing User Services Configuration Guide Library, Cisco IOS Release 12.4T* and *Cisco IOS Security Command Reference*.

Step 4	**username** *name* {**no password** | **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 a transform set that contains such a transform is found, it is selected and applied to the protected traffic as a part of both peers' configurations.

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

SUMMARY STEPS

1. **crypto ipsec profile** *profile-name*
2. **crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*] [*transform4*]
3. **crypto ipsec security-association lifetime** {**seconds** *seconds* | **kilobytes** *kilobytes*}

DETAILED STEPS

	Command or Action	Purpose

Step 1	**crypto ipsec profile** *profile-name*
	
	Example:
	`Router(config)# crypto ipsec profile pro1`
	`Router(config)#`
		Configures IPSec profile to apply protection on the tunnel for encryption.

Step 2	**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 *Secure Connectivity Configuration Guide Library, Cisco IOS Release 12.4T* for details about the valid transforms and combinations.

Step 3	**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.

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).

To configure the IPSec crypto method, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **crypto dynamic-map** *dynamic-map-name dynamic-seq-num*
2. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
3. **reverse-route**
4. **exit**
5. **crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*]

DETAILED STEPS

	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 *Cisco IOS Security Command Reference* for more details 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 *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 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.

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

SUMMARY STEPS

1. **interface** *type number*
2. **crypto map** *map-name*
3. **exit**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 4`
	`Router(config-if)#`
		Enters the interface configuration mode for the interface to which you want the crypto map applied.

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 *Cisco IOS Security Command Reference* for more details about this command.

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

Where to Go Next

If you are creating a Cisco Easy VPN remote configuration, go to the "Create a Cisco Easy VPN Remote Configuration" section on page 9-15.

If you are creating a site-to-site VPN using IPSec tunnels and GRE, go to the "Configure a Site-to-Site GRE Tunnel" section on page 9-17.

Create a Cisco Easy VPN Remote Configuration

The router acting as the Cisco Easy VPN client must create a Cisco Easy VPN remote configuration and assign it to the outgoing interface.

To create the remote configuration, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **crypto ipsec client ezvpn** *name*
2. **group** *group-name* **key** *group-key*
3. **peer** {*ip address* | *hostname*}
4. **mode** {**client** | **network-extension** | **network extension plus**}
5. **exit**
6. **crypto isakmp keepalive** *seconds*
7. **interface** *type number*
8. **crypto ipsec client ezvpn** *name* [**outside** | **inside**]
9. **exit**

DETAILED STEPS

	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** {*ip address* | *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.
		
		Note Use this command to configure multiple peers for use as backup. If one peer goes down, the Easy VPN tunnel is established with the second available peer. When the primary peer comes up again, the tunnel is re-established with the primary peer.

	Command or Action	Purpose

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.

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

Step 6	**crypto isakmp keepalive** *seconds*
	
	Example:
	`Router(config-crypto-ezvpn)# crypto isakmp keepalive 10`
	`Router(config)#`
		Enables dead peer detection messages. Time between messages is given in *seconds*, with a range of 10 to 3600.

Step 7	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 4`
	`Router(config-if)#`
		Enters the interface configuration mode for the interface to which you want the Cisco Easy VPN remote configuration applied.
		
		Note For routers with an ATM WAN interface, this command would be **interface atm 0**.

Step 8	**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 port address translation (PAT) and access list configuration needed for the VPN connection.

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

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 4
    crypto ipsec client ezvpn ezvpnclient outside
    crypto map static-map
!
interface vlan 1
    crypto ipsec client ezvpn ezvpnclient inside
!
```

Configure a Site-to-Site GRE Tunnel

To configure a GRE tunnel, perform these steps, beginning in global configuration mode:

SUMMARY STEPS

1. **interface** *type number*
2. **ip address** *ip-address mask*
3. **tunnel source** *interface-type number*
4. **tunnel destination** *default-gateway-ip-address*
5. **crypto map** *map-name*
6. **exit**
7. **ip access-list** {**standard** | **extended**} *access-list-name*
8. **permit** *protocol source source-wildcard destination destination-wildcard*
9. **exit**

DETAILED STEPS

	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.

Step 3	**tunnel source** *interface-type number*
	
	Example:
	`Router(config-if)# tunnel source fastethernet 0`
	`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.

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.

	Command or Action	Purpose

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 0

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
!
! Defines the key association and authentication for IPsec tunnel.
crypto isakmp policy 1
hash md5
authentication pre-share
crypto isakmp key cisco123 address 200.1.1.1
!
!
! Defines encryption and transform set for the IPsec tunnel.
crypto ipsec transform-set set1 esp-3des esp-md5-hmac
!
! Associates all crypto values and peering address for the IPsec tunnel.
crypto map to_corporate 1 ipsec-isakmp
 set peer 200.1.1.1
 set transform-set set1
 match address 105
!
!
! VLAN 1 is the internal home network.
interface vlan 1
 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
!
! FE4 is the outside or Internet-exposed interface
interface fastethernet 4
 ip address 210.110.101.21 255.255.255.0
 ! acl 103 permits IPsec traffic from the corp. router as well as
 ! denies Internet-initiated traffic inbound.
 ip access-group 103 in
 ip nat outside
 no cdp enable
 crypto map to_corporate ! Applies the IPsec tunnel to the outside interface.
!
! Utilize NAT overload in order to make best use of the
! single address provided by the ISP.
ip nat inside source list 102 interface Ethernet1 overload
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
! Allow ICMP for debugging but should be disabled because of security implications.
access-list 103 permit icmp any any
access-list 103 deny ip any any ! Prevents Internet-initiated traffic inbound.
! acl 105 matches addresses for the IPsec tunnel to or 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
```

CHAPTER 10

Configuring the Ethernet Switches

This chapter gives an overview of configuration tasks for the 4-port Fast Ethernet (FE) switch and for the Gigabit Ethernet (GE) switch that services the embedded wireless access point on the Cisco 819 Integrated Services Routers (ISRs).

The FE switches are 10/100Base T Layer 2 Fast Ethernet switches. Traffic between different VLANs on a switch is routed through the router platform with the switched virtual interface (SVI).

The GE switch is a 1000Base T Layer 2 Gigabit Ethernet switch with an internal interface between the router and its embedded wireless access point.

Any switch port may be configured as a trunking port to connect to other Cisco Ethernet switches.

This chapter contains the following sections:

- Switch Port Numbering and Naming, page 10-1
- Restrictions for the FE Switch, page 10-1
- Information About Ethernet Switches, page 10-2
- Overview of SNMP MIBs, page 10-3
- How to Configure Ethernet Switches, page 10-6

Switch Port Numbering and Naming

The ports on the FE switch are numbered FE0 through FE3. The port on the GE switch is named and numbered Wlan-GigabitEthernet0.

Restrictions for the FE Switch

The following restrictions apply to the FE switch:

- The ports of an FE switch must NOT be connected to any Fast Ethernet onboard port of the router.
- Inline power is not supported on Cisco 819 ISRs.
- VTP pruning is not supported.
- The FE switch can support up to 200 secure MAC addresses.

Information About Ethernet Switches

To configure Ethernet switches, you should understand the following concept:

- VLANs and VLAN Trunk Protocol, page 10-2
- Layer 2 Ethernet Switching, page 10-2
- 802.1x Authentication, page 10-2
- Spanning Tree Protocol, page 10-2
- Cisco Discovery Protocol, page 10-2
- Switched Port Analyzer, page 10-3
- IGMP Snooping, page 10-3
- Storm Control, page 10-3
- Fallback Bridging, page 10-3

VLANs and VLAN Trunk Protocol

For information on the concept of VLANs and VLAN Trunk Protocol (VTP), see *VLANs*.

Layer 2 Ethernet Switching

For information on the concept of Layer 2 Ethernet Switching, see *Layer 2 Ethernet Switching*.

802.1x Authentication

For information on the concept of 802.1x Authentication, see *802.1x Authentication*.

Spanning Tree Protocol

For information on the concept of Spanning Tree Protocol, see *Using the Spanning Tree Protocol with the Cisco EtherSwitch Network Module*.

Cisco Discovery Protocol

Cisco Discovery Protocol (CDP) runs over Layer 2 (the data link layer) on all Cisco routers, bridges, access servers, and switches. CDP allows network management applications to discover Cisco devices that are neighbors of already known devices, in particular, neighbors running lower-layer, transparent protocols. With CDP, network management applications can learn the device type and the SNMP agent address of neighboring devices. This feature enables applications to send SNMP queries to neighboring devices.

CDP runs on all LAN and WAN media that support Subnetwork Access Protocol (SNAP). Each CDP-configured device sends periodic messages to a multicast address. Each device advertises at least one address at which it can receive SNMP messages. The advertisements also contain the time-to-live, or hold-time information, which indicates the length of time a receiving device should hold CDP information before discarding it.

Switched Port Analyzer

For information on the concept of Switched Port Analyzer, see *Switched Port Analyzer*.

IGMP Snooping

For information on the concept of IGMP Snooping, see *IGMP Snooping*.

IGMP Version 3

The Cisco 819 ISRs support Version 3 of IGMP snooping.

IGMPv3 provides support for source filtering, which enables a multicast receiver host to signal to a router which groups the receiver host wants to receive multicast traffic from and from which sources this traffic is expected. Enabling the IGMPv3 feature with IGMP snooping on Cisco ISRs provides Basic IGMPv3 Snooping Support (BISS). BISS provides constrained flooding of multicast traffic in the presence of IGMPv3 hosts. This support constrains traffic to approximately the same set of ports as IGMPv2 snooping does with IGMPv2 hosts. The constrained flooding only considers the destination multicast address.

Storm Control

For information on the concept of storm control, see *Storm Control*.

Fallback Bridging

For information on the concept of fallback bridging, see *Fallback Bridging*.

Overview of SNMP MIBs

Simple Management Network Protocol (SNMP) development and use is centered around the Management Information Base (MIB). An SNMP MIB is an abstract data base and it is a conceptual specification for information that a management application may read and modify in a certain form. This does not imply that the information is kept in the managed system in that same form. The SNMP agent translates between the internal data structures and formats of the managed system and the external data structures and formats defined for the MIB.

The SNMP MIB is conceptually a tree structure with conceptual tables. Cisco Layer 2 Switching Interface MIB is discussed in more detail in the next section. Relative to this tree structure, the term MIB is used in two senses. In one sense, it is actually a MIB branch, usually containing information for a single aspect of technology, such as a transmission medium or a routing protocol. A MIB used in this

sense is more accurately called a MIB module and is usually defined in a single document. In the other sense, a MIB is a collection of such branches. Such a collection might comprise, for example, all the MIB modules implemented by a given agent or the entire collection of MIB modules defined for SNMP.

A MIB is a tree where the leaves are individual items of data called objects. An object may be, for example, a counter or a protocol status. MIB objects are also sometimes called variables.

For a list of MIBs supported on Cisco 819 4G LTE routers, see the "SNMP MIBs" section of *Configuring Cisco 4G LTE Wireless WAN EHWIC*.

MIBs were modified in IOS release 15.2(4)M1 to support Cisco 819HGW and Cisco 819HWD SKUs. Table 10-1 lists the MIBs for Cisco 819 ISRs.

Table 10-1 MIBs for Cisco 819 ISRs

MIBs	MIBs Link
CISCO-PRODUCTS-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://tools.cisco.com/ITDIT/MIBS/servlet/index
CISCO-ENTITY-VENDORTYPE-OID-MIB	
OLD-CISCO-CHASSIS-MIB	
CISCO-WAN-3G-MIB	

BRIDGE-MIB for Layer 2 Ethernet Switching

The Layer 2 Ethernet Switching Interface BRIDGE-MIB is supported in the Cisco 819 platforms. The BRIDGE-MIB enables the user to know the Media Access Control (MAC) addresses and spanning tree information of the Ethernet switch modules. The user can query the MIB agent using the SNMP protocol and get the details of Ethernet switch modules such as MAC addresses of each interfaces and spanning protocol information.

The Bridge-MIB uses the following approaches to get the L2 layers BRIDGE-MIB information:

- Community-string-based approach
- Context-based approach

In the community-string-based approach, one community string is created for each VLAN. Based on the query, the respective VLAN MIB is displayed.

To get the BRIDGE-MIB details, use the **snmp-server community public RW** command in the configuration mode.

`Router(config)#`**snmp-server community public RW**

Use the following syntax to query the SNMP BRIDGE-MIB details:

```
snmpwalk -v2c <ip address of the ISR, …>  public .1.3.6.1.2.1.17
snmpwalk -v2c <ip address of the ISR, …>  public@2 .1.3.6.1.2.1.17
snmpwalk -v2c <ip address of the ISR, …>  public@3 .1.3.6.1.2.1.17
```

Note When you create a VLAN "x", the logical entity public@x is added. If you query with the public community, the L3 MIB is displayed. When you query with public@x, the L2 MIB for VLAN "x" is displayed.

In the context-based approach, the SNMP context mapping commands are used to display the values for L2 interfaces. Each VLAN is mapped to a context. When the user queries with a context, the MIB displays the data for that specific VLAN, which is mapped to the context. In this approach, each VLAN is manually mapped to a context.

To get the BRIDGE-MIB details, use the following commands in the configuration mode:

```
Router(config)#Routersnmp-server group public v2c context bridge-group
Router(config)#snmp-server community public RW
Router(config)#snmp-server community private RW
Router(config)#snmp-server context bridge-group
Router(config)#snmp mib community-map public context bridge-group
```

Use the following syntax to query the SNMP BRIDGE-MIB details:

```
snmpwalk -v2c <ip address of the ISR, …>  public@1 .1.3.6.1.2.1.17 ?L2-MIB
snmpwalk -v2c <ip address of the ISR, …>  private .1.3.6.1.2.1.17?L3-MIB
```

Note When you query with the public community, the L2 MIB is displayed. Use the private group for L3 MIB.

For more details to configure and retrieve the BRIDGE-MIB details, see *The BRIDGE-MIB*.

MAC Address Notification

MAC address notification enables you to track users on a network by storing the MAC address activity on the switch. Whenever the switch learns or removes a MAC address, an SNMP notification can be generated and sent to the NMS. If you have many users coming and going from the network, you can set a trap interval time to bundle the notification traps and reduce network traffic. The MAC notification history table stores the MAC address activity for each hardware port for which the trap is enabled. MAC address notifications are generated for dynamic and secure MAC addresses; events are not generated for self addresses, multicast addresses, or other static addresses.

For more details to configure MAC address notification, see *Configuring MAC Address Notification Traps*.

How to Configure Ethernet Switches

See the following sections for configuration tasks for Ethernet switches.

- Configuring VLANs, page 10-6
- Configuring Layer 2 Interfaces, page 10-7
- Configuring 802.1x Authentication, page 10-8
- Configuring Spanning Tree Protocol, page 10-8
- Configuring MAC Table Manipulation, page 10-9
- Configuring Cisco Discovery Protocol, page 10-9
- Configuring the Switched Port Analyzer, page 10-10
- Configuring IP Multicast Layer 3 Switching, page 10-10
- Configuring IGMP Snooping, page 10-10
- Configuring Per-Port Storm Control, page 10-10
- Configuring Fallback Bridging, page 10-11
- Managing the Switch, page 10-12

Configuring VLANs

This section provides information on how to configure VLANs. The Cisco 819 ISRs support 2 VLANs and the Cisco 819 ISRs support 8 VLANs.

- VLANs on the FE Ports, page 10-6
- VLANs on the GE Port, page 10-7

VLANs on the FE Ports

Perform these steps to configure VLANs, beginning in configuration mode.

	Command	Purpose
Step 1	**interface fe** *port*	Selects the Fast Ethernet port to configure.
Step 2	**shutdown**	(Optional) Shuts down the interface to prevent traffic flow until configuration is complete.

	Command	Purpose
Step 3	`switchport`	Configures the Fast Ethernet port for Layer 2 switching. **Note** You must enter the **switchport** command once without any keywords to configure the Fast Ethernet port as a Layer 2 port before you can enter additional switchport commands with keywords. This command creats a Cisco default VLAN. This configuration sets the default trunking administrative mode to **switchport mode dynamic desirable** and the trunk encapsulation to **negotiate**. By default, all VLANs created are included in the default trunk.
Step 4	`switchport access vlan` *vlan_id*	Creates instances of additional VLANs. Allowable values of *vlan_id* are 2 to 4094, except for reserved values of 1002 to 1005.
Step 5	`no shutdown`	Activates the interface.
Step 6	`end`	Exits configuration mode.

For additional information, see *Layer 2 LAN Ports*.

VLANs on the GE Port

Because the GE port is an internal interface that services only the router's embedded access point, it cannot be configured only with the command **switchport access vlan X**, where X is other than 1. It may, however, be configured in trunk mode. This may be done by performing the following steps, beginning in configuration mode.

	Comand	Purpose
Step 1	`interface` *Wlan-GigabitEthernet0*	Selects the Gigabit Ethernet port to configure.
Step 2	`switchport mode trunk`	Places the port in trunk mode.
Step 3	`switchport access vlan` *vlan_id*	(Optional) Once the port is in trunk mode, it may be assigned a VLAN number other than 1.

Configuring Layer 2 Interfaces

For information on how to configure Layer 2 interfaces, see *Configuring Layer 2 Interfaces*.

This section contains information on the following topics:

- Configuring a range of interfaces
- Defining a range macro
- Configuring Layer 2 optional interface features

Configuring 802.1x Authentication

For information on how to configure 802.1x port-based authentication, see *Configuring IEEE 802.1x Port-Based Authentication*.

This section contains information on the following topics:

- Understanding the default 802.1x configuration
- Enabling 802.1x Authentication
- Configuring the switch-to-RADIUS-server comunication
- Enabling periodic reauthentication
- Changing the quiet period
- Changing the switch-to-client retransmission time
- Setting the switch-to-client frame-retransmission number
- Enabling multiple hosts
- Resetting the 802.1x configuration to default values
- Displaying 802.1x statistics and status

Configuring Spanning Tree Protocol

For information on how to configure Spanning Tree Protocol, see *Configuring Spanning Tree*.

This section contains information on the following topics:

- Enabling spanning tree
- Configuring spanning tree port priority
- Configuring spanning tree port cost
- Configuring the bridge priority of a VLAN
- Configuring the Hello Time
- Configuring the forward-delay time for a VLAN
- Configuring the maximum aging time for a VLAN
- Disabling spanning tree

Configuring MAC Table Manipulation

For information on how to configure MAC table manipulation, see *Configuring MAC Table Manipulation*.

Port Security

The topic of enabling known MAC address traffic deals with port security. Port security can be either static or dynamic.

Static port security allows the user to specify which devices are allowed access through a given switch port. The specification is done manually by placing allowed device MAC addresses in the MAC address table. Static port security is also known as MAC address filtering.

Dynamic port security is similar. However, instead of specifying the MAC address of the devices, the user specifies the maximum number of devices that will be allowed on the port. If the maximum number specified is more than the number of MAC addresses specified manually, the switch will learn the MAC address automatically, up to the maximum specified. If the maximum number specified is less than the number of MAC addresess already specified statically, an error message will be produced.

The following command is used to specify static or dynamic port security.

Command	Purpose
`Router(config)# mac-address-table secure [<mac-address> | maximum maximum addresses] fastethernet interface-id [vlan <vlan id>]`	*<mac-address>* enables static port security. Use of the keyword **maximum** enables dynamic port security.

Configuring Cisco Discovery Protocol

For information on how to configure Cisco Discovery Protocol (CDP), see *Configuring Cisco Discovery Protocol*.

This section contains information on the following topics:

- Enabling CDP
- Enabling CDP on an interface
- Monitoring and maintaining CDP

Configuring the Switched Port Analyzer

For information on how to configure a switched port analyzer (SPAN) session, see *Configuring the Switched Port Analyzer (SPAN)*.

This section contains information on the following topics:

- Configuring the SPAN sources
- Configuring SPAN destinations
- Verifying the SPAN session
- Removing sources or destinations from a SPAN session

Configuring IP Multicast Layer 3 Switching

For information on how to configure IP multicast Layer 3 switching, see *Configuring IP Multicast Layer 3 Switching*.

This section contains information on the following topics:

- Enabling IP multicast routing globally
- Enabling IP protocol-independent multicast (PIM) on Layer 3 interfaces
- Verifying IP multicast Layer 3 hardware switching summary
- Verifying the IP multicast routing table

Configuring IGMP Snooping

For information on how to configure IGMP snooping, see *Configuring IGMP Snooping*.

This section contains information on the following topics:

- Enabling or disabling IGMP snooping
- Enabling IGMP immediate-leave processing
- Statically configuring an interface to join a group
- Configuring a multicast router port

IGMP Version 3

In support of the IGMPv3 feature in Cisco IOS Release 12.4(15)T, the **groups** and **count** keywords were added to the **show ip igmp snooping** command, and the output of the **show ip igmp snooping** command was modified to include global information about IGMP snooping groups. Use the **show ip igmp snooping** command with the **groups** keyword to display the multicast table learned by IGMP snooping for all VLANs or the **show ip igmp snooping** command with the **groups** keyword, **vlan-id** keyword, and *vlan-id* argument to display the multicast table learned by IGMP snooping for a specific VLAN. Use the **show ip igmp snooping** command with the **groups** and **count** keywords to display the number of multicast groups learned by IGMP snooping.

Configuring Per-Port Storm Control

For information on how to configure per-port storm control, see *Configuring Per-Port Storm-Control*.

This section contains information on the following topics:

- Enabling per-port storm-control
- Disabling per-port storm-control

Configuring Fallback Bridging

For information on how to configure fallback bridging, see *Configuring Fallback Bridging*.

This section contains information on the following topics:

- Understanding the default fallback bridging configuration
- Creating a bridge group
- Preventing the forwarding of dynamically learned stations
- Configuring the bridge table aging time
- Filtering frames by a specific MAC address
- Adjusting spanning-tree parameters
- Monitoring and maintaining the network

Managing the Switch

For information on management of the switch, see *Managing the EtherSwitch HWIC*.

This section contains information on the following topics:

- Adding Trap Managers
- Configuring IP Information
- Enabling Switch Port Analyzer
- Managing the ARP Table
- Managing the MAC Address Tables
- Removing Dynamic Addresses
- Adding Secure Addresses
- Configuring Static Addresses
- Clearing all MAC Address Tables

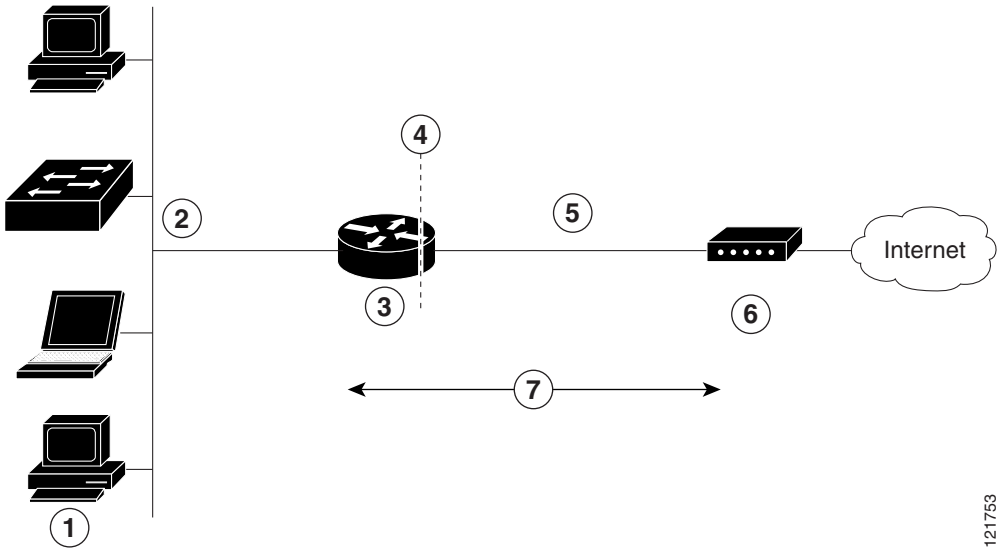
CHAPTER 11

Configuring PPP over Ethernet with NAT

This chapter provides an overview of Point-to-Point Protocol over Ethernet (PPPoE) clients and Network Address Translation (NAT) that can be configured on the Cisco 819 Integrated Services Routers (ISRs).

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 11-1 shows a typical deployment scenario with a PPPoE client and NAT configured on the Cisco router.

Figure 11-1 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 819 ISRs
4	Point at which NAT occurs
5	Fast Ethernet WAN interface (outside interface for NAT)
6	Cable modem or other 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 819 ISRs. 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 re-establish 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 re-establish 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, page 11-2
- Configure the Fast Ethernet WAN Interfaces, page 11-3
- Configure the Dialer Interface, page 11-4
- Configure Network Address Translation, page 11-6

An example showing the results of these configuration tasks is shown in the "Configuration Example" section on page 11-9.

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.

SUMMARY STEPS

1. **vpdn enable**
2. **vpdn-group** *name*
3. **request-dialin**
4. **protocol** {**l2tp** | **pppoe**}
5. **exit**
6. **exit**

DETAILED STEPS

	Command or Action	Purpose

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

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

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

Step 4	**protocol** {**l2tp** | **pppoe**}
	
	Example:
	`Router(config-vpdn-req-in)# protocol pppoe`
	`Router(config-vpdn-req-in)#`
		Specifies the type of sessions the VPDN subgroup can establish.

Step 5	**exit**
	
	Example:
	`Router(config-vpdn-req-in)# exit`
	`Router(config-vpdn)#`
		Exits request-dialin VPDN group configuration.

Step 6	**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.

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

SUMMARY STEPS

1. **interface type** *number*
2. **pppoe-client dial-pool-number** *number*
3. **no shutdown**
4. **exit**

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 4`
	`Router(config-if)#`
		Enters interface configuration mode for a Fast Ethernet WAN interface.

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.

SUMMARY STEPS

1. **interface dialer** *dialer-rotary-group-number*
2. **ip address negotiated**
3. **ip mtu** *bytes*
4. **encapsulation** *encapsulation-type*
5. **ppp authentication** {*protocol1* [*protocol2*...]}
6. **dialer pool** *number*
7. **dialer-group** *group-number*
8. **exit**
9. **dialer-list** *dialer-group* **protocol** *protocol-name* {**permit** | **deny** | **list** access-list-number | **access-group**}
10. **ip route** *prefix mask* {*interface-type interface-number*}

DETAILED STEPS

	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 to 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 *Cisco IOS Security Command Reference*.

	Command	Purpose

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.

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 to 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 *Cisco IOS Dial Technologies Command Reference*.

Step 10	**ip route** *prefix mask* {*interface-type interface-number*}
	
	Example:
	`Router(config)# ip route 10.10.25.2 255.255.255.255 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 *Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols, Release 12.2* and *Cisco IOS IP Command Reference, Volume 2 of 4: Routing Protocols, Release 12.3.*

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:

SUMMARY STEPS

1. **ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
2. **ip nat inside source** {**list** *access-list-number*} {**interface type** *number* | **pool** *name*} [**overload**]
3. **interface** *type number*
4. **ip nat** {**inside** | **outside**}
5. **no shutdown**
6. **exit**
7. **interface** *type number*
8. **ip nat** {**inside** | **outside**}
9. **no shutdown**
10. **exit**
11. **access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*]

DETAILED STEPS

	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 255.255.252.0`
	`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:
	`Router(config)# ip nat inside source list 1 interface dialer 0 overload`
	
	or
	
	Example:
	`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 *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 [FE0–FE3] 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 *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 4`
	`Router(config-if)#`
		Enters configuration mode for the Fast Ethernet WAN interface (FE4) 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 *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 192.168.1.0 255.255.255.0`	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 the "Basic Router Configuration" section on page 5-1 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 concept, see the "Cisco IOS Software Basic Skills" section on page A-1.

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 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 4
no ip address
no ip directed-broadcast (default)
ip nat outside
pppoe enable group global
pppoe-client dial-pool-number 1
no sh
!
interface dialer 0
ip address negotiated
ip mtu 1492
encapsulation ppp
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 10.10.25.2 255.255.255.255 dialer 0
ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 255.255.252.0
ip nat inside source list acl1 pool pool1
!
```

Verifying Your Configuration

Use the **show ip nat statistics** command in privileged EXEC mode to verify the PPPoE 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:
  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
```

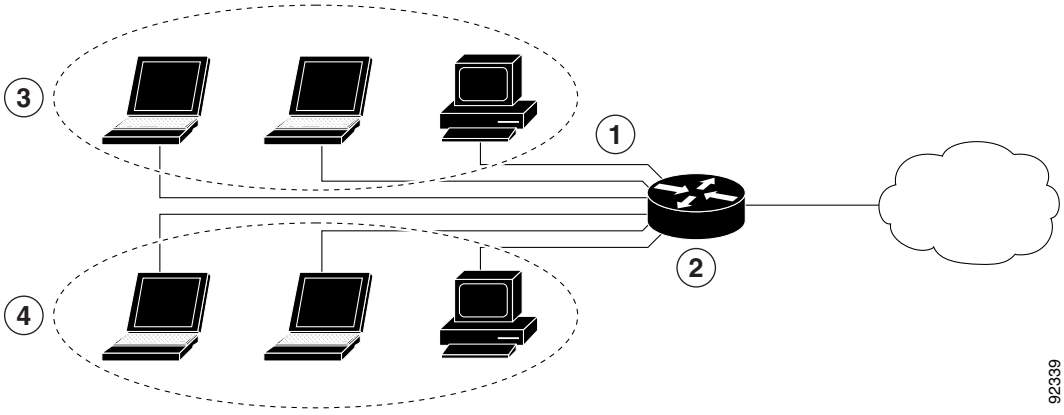
CHAPTER 12

Configuring a LAN with DHCP and VLANs

The Cisco 819 Integrated Services Routers (ISRs) 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.

Figure 12-1 shows a typical deployment scenario with two physical LANs connected by the router and two VLANs.

Figure 12-1 Physical and Virtual LANs with DHCP Configured on the Cisco Router



1	Fast Ethernet LAN (with multiple networked devices)
2	Router and DHCP server—Cisco 819 ISR—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 800 series 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 819 routers support four Fast Ethernet ports on which you can configure VLANs.

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, page 12-2
- Configure VLANs, page 12-5

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 the "Basic Router Configuration" section on page 5-1 and "Configuring a VPN Using Easy VPN and an IPSec Tunnel" section on page 13-1 as appropriate for your router.

Configure DHCP

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

SUMMARY STEPS

1. **ip domain name** *name*
2. **ip name-server** *server-address1* [*server-address2...server-address6*]
3. **ip dhcp excluded-address** *low-address* [*high-address*]
4. **ip dhcp pool** *name*
5. **network** *network-number* [*mask* | *prefix-length*]
6. **import all**
7. **default-router** *address* [*address2...address8*]
8. **dns-server** *address* [*address2...address8*]
9. **domain-name** *domain*
10. **exit**

DETAILED STEPS

	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.

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 10.10.10.10`
	`Router(config-dhcp)#`
		Specifies up to eight default routers for a DHCP client.

	Command	Purpose

Step 8	**dns-server** *address* [*address2...address8*]
	
	Example:
	`Router(config-dhcp)# dns-server 192.168.35.2`
	`Router(config-dhcp)#`
		Specifies up to eight 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:

SUMMARY STEPS

1. **vlan ?**
2. **ISL VLAN** *ID*
3. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**vlan ?**
	Example:
	`Router# config t`
	`Router(config)# vlan database?`
	
	`WORD  ISL VLAN IDs 1-4094`
	`accounting  VLAN accounting configuration`
	`ifdescr  VLAN subinterface ifDescr`
	
	`Router(config)# vlan 2`
		Enters VLAN configuration mode.

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

Assign a Switch Port to a VLAN

Perform these steps to assign a switch port to a VLAN, beginning in global configuration mode:

SUMMARY STEPS

1. **interface** *switch port id*
2. **switchport access vlan** *vlan-id*
3. **end**

DETAILED STEPS

	Command	Purpose

Step 1	**interface** *switch port id*
	
	Example:
	`Router(config)# interface FastEthernet 2`
	`Router(config-if)#`
		Specifies the switch port that you want to assign to the VLAN.

Step 2	**switchport access vlan** *vlan-id*
	
	Example:
	`Router(config-if)# switchport access vlan 2`
	`Router(config-if)#`
		Assigns a port to the VLAN.

Step 3	**end**
	
	Example:
	`Router(config-if)# end`
	`Router#`
		Exits interface mode and returns to privileged EXEC 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: 2
    Name: VLAN0002
    Media Type: Ethernet
    VLAN 802.10 Id: 100002
    State: Operational
    MTU: 1500

  VLAN ISL Id: 3
    Name: red-vlan
    Media Type: Ethernet
    VLAN 802.10 Id: 100003
    State: Operational
    MTU: 1500

  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, Fa3
2    VLAN0002                         active    Fa2
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
2    enet  100002     1500  -      -      -        -    -        0      0
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
```

CHAPTER 13

Configuring a VPN Using Easy VPN and an IPSec Tunnel

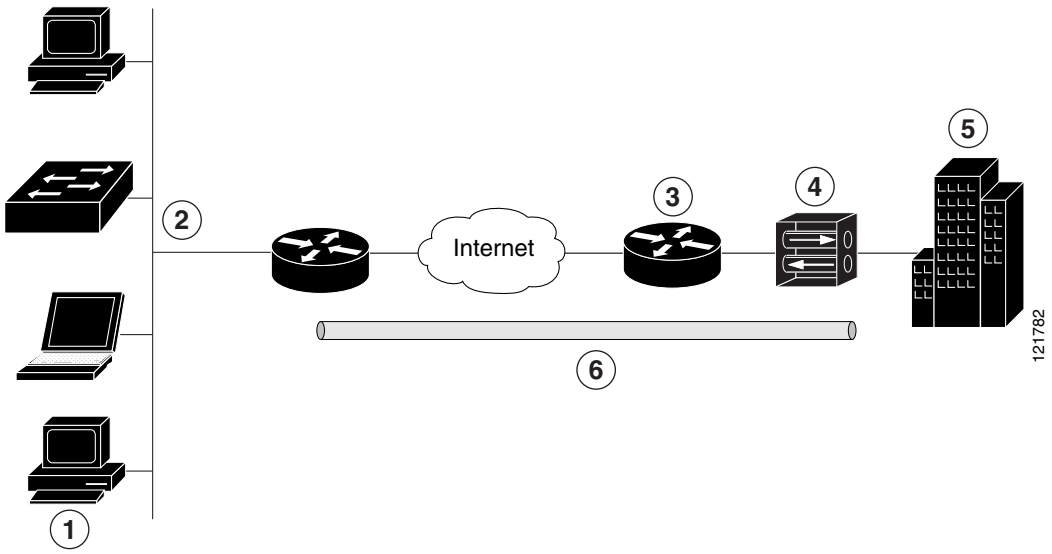
This chapter provides an overview of the creation of Virtual Private Networks (VPNs) that can be configured on the Cisco 819 Integrated Services Routers (ISRs).

Cisco routers and other broadband devices provide high-performance connections to the Internet, but many applications also require the security of VPN connections that perform a high level of authentication and that 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 13-1 shows a typical deployment scenario.

Figure 13-1 Remote Access VPN Using IPSec Tunnel



1	Remote, networked users
2	VPN client—Cisco 819 ISRs
3	Router—Providing the corporate office network access
4	VPN server—Easy VPN server
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 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 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 819 ISR. 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 the 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, page 13-3
- Configure Group Policy Information, page 13-5
- Apply Mode Configuration to the Crypto Map, page 13-6
- Enable Policy Lookup, page 13-7
- Configure IPSec Transforms and Protocols, page 13-8
- Configure the IPSec Crypto Method and Parameters, page 13-8
- Apply the Crypto Map to the Physical Interface, page 13-10
- Create an Easy VPN Remote Configuration, page 13-10

An example showing the results of these configuration tasks is provided in the "Configuration Example" section on page 13-12.

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 "Basic Router Configuration" section on page 5-1.

Note The examples shown in this chapter refer only to the endpoint configuration on the Cisco 819 router. Any VPN connection requires both endpoints be configured properly to function. See the software configuration documentation as needed to configure VPN for other router models.

Configure the IKE Policy

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

SUMMARY STEPS

1. **crypto isakmp policy** *priority*
2. **encryption** {**des** | **3des** | **aes** | **aes 192** | **aes 256**}
3. **hash** {**md5** | **sha**}
4. **authentication** {**rsa-sig** | **rsa-encr** | **pre-share**}
5. **group** {**1** | **2** | **5**}

6. **lifetime** *seconds*
7. **exit**

DETAILED STEPS

	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.

Step 6	**lifetime** *seconds*
	
	Example:
	`Router(config-isakmp)# lifetime 480`
	`Router(config-isakmp)#`
		Specifies the lifetime, 60 to 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:

SUMMARY STEPS

1. **crypto isakmp client configuration group** {**group-name** | **default**}
2. **key** *name*
3. **dns** *primary-server*
4. **domain** *name*
5. **exit**
6. **ip local pool** {**default** | *poolname*} [*low-ip-address* [*high-ip-address*]]

DETAILED STEPS

	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 *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:

SUMMARY STEPS

1. **crypto map** *map-name* **isakmp authorization list** *list-name*
2. **crypto map** *tag* **client configuration address** [**initiate** | **respond**]

DETAILED STEPS

	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:

SUMMARY STEPS

1. **aaa new-model**
2. **aaa authentication login** {**default** | *list-name*} *method1* [*method2*...]
3. **aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2*...]]
4. **username** *name* {**nopassword** | **password** *password* | **password** *encryption-type encrypted-password*}

DETAILED STEPS

	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 *Securing User Services Configuration Guide Library, Cisco IOS Release 12.4T* 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 *Securing User Services Configuration Guide Library, Cisco IOS Release 12.4T* 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:

SUMMARY STEPS

1. **crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*] [*transform4*]
2. **crypto ipsec security-association lifetime** {**seconds** *seconds* | **kilobytes** *kilobytes*}

DETAILED STEPS

	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 *Cisco IOS Security Command Reference* for details 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 *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:

SUMMARY STEPS

1. **crypto dynamic-map** *dynamic-map-name dynamic-seq-num*
2. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
3. **reverse-route**
4. **exit**
5. **crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*]

DETAILED STEPS

	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 *Cisco IOS Security Command Reference* for more details 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 *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:

SUMMARY STEPS

1. **interface** *type number*
2. **crypto map** *map-name*
3. **exit**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 4`
	`Router(config-if)#`
		Enters the interface configuration mode for the interface to which you want the crypto map applied.

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 *Cisco IOS Security Command Reference* for more details 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:

SUMMARY STEPS

1. **crypto ipsec client ezvpn** *name*
2. **group** *group-name* **key** *group-key*
3. **peer** {*ipaddress* | *hostname*}

4. **mode** {**client** | **network-extension** | **network extension plus**}
5. **exit**
6. **interface** *type number*
7. **crypto ipsec client ezvpn** *name* [**outside** | **inside**]
8. **exit**

DETAILED STEPS

	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.

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 4`
	`Router(config-if)#`
		Enters the interface configuration mode for the interface to which you want the Cisco Easy VPN remote configuration applied.
		
		Note For routers with an ATM WAN interface, this command would be **interface atm 0**.

	Command or Action	Purpose

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 port address translation (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

The following example verifies your easy vpn connection:

```
Router# show crypto ipsec client ezvpn

Tunnel name :ezvpnclient
Inside interface list:vlan 1
Outside interface:fastethernet 4
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 4
    crypto ipsec client ezvpn ezvpnclient outside
    crypto map static-map
!
interface vlan 1
    crypto ipsec client ezvpn ezvpnclient inside
!
```

APPENDIX A

Cisco IOS Software Basic Skills

Understanding how to use Cisco IOS software can save you time when you are configuring your router. This appendix contains the following sections which provide basic information:

- Configuring the Router from a PC, page A-1
- Understanding Command Modes, page A-2
- Getting Help, page A-4
- Enable Secret Passwords and Enable Passwords, page A-5
- Entering Global Configuration Mode, page A-5
- Using Commands, page A-6
- Saving Configuration Changes, page A-7
- Summary, page A-7
- Where to Go Next, page A-7

If you are already familiar with Cisco IOS software, go to the following chapter:

- Basic Router Configuration, page 5-1

Configuring the Router from a PC

You can configure your router from a PC that is connected through the console port by using terminal emulation software. The PC uses this software to send commands to your router. Table A-1 lists some common types of terminal emulation software that you can use, depending on the operating system that you are running.

Table A-1 Types of Terminal Emulation Software

PC Operating System	Terminal Emulation 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

You can use the terminal emulation software to change settings for the router that is connected to the PC. 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 the "ROM Monitor" section on page C-1. To change the router flow control setting, use the **flowcontrol** command in global configuration mode.

For information on how to enter global configuration mode so that you can configure your router, see the "Entering Global Configuration Mode" section on page A-5.

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, describes how to access each mode, shows the prompt for each mode, and explains how to exit to a mode or enter another 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 Release 12.3* documentation set.

Table A-2 Command Modes Summary

Mode	Access Method	Prompt	Mode Exit and Entrance	About This Mode
User EXEC	Begin a session with your router.	`Router>`	To exit a router session, enter the **logout** command.	Use this mode to: • 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 to: • Configure your router operating parameters. • Perform the verification steps shown in this guide. To prevent unauthorized changes to your router configuration, protect access to this mode by using a password as described in the "Enable Secret Passwords and Enable Passwords" procedure on page A-5.
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 globally. From this mode, you can access the following modes: • 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 by using 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	Mode Exit and Entrance	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 and optional line type, 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 for a prticular 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> sh?
* 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 that 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 pound sign (#) 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 that 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.	Re-enter 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 the keywords or values required by this command.	Re-enter 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 the commands that are available in this particular command mode.

Saving Configuration Changes

You must enter the **copy running-config startup-config** command to save your configuration changes to 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.
- 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 the "Basic Router Configuration" section on page 5-1.

APPENDIX B

Concepts

This appendix contains conceptual information that may be useful to Internet service providers or network administrators when they configure Cisco routers.

The following topics are included in this appendix:

- Network Protocols, page B-1
- Routing Protocol Options, page B-2
- PPP Authentication Protocols, page B-3
- TACACS+, page B-4
- Ethernet, page B-4
- Dial Backup, page B-5
- NAT, page B-6
- Easy IP (Phase 1), page B-6
- Easy IP (Phase 2), page B-7
- QoS, page B-7
- Access Lists, page B-9

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 sections.

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 that is 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 originated 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 understand 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 understand 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 anytime 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 819 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.

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. 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.

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, page B-5
- Floating Static Routes, page B-5
- Dialer Watch, page B-5

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 can 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 that are temporarily connected to the network 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 User Datagram Protocol (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, page B-8
- PPP Fragmentation and Interleaving, page B-8
- CBWFQ, page B-8
- RSVP, page B-8
- Low Latency Queuing, page B-9

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 classes 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 queueing [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 queuing; 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.

APPENDIX C

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, page C-1
- ROM Monitor Commands, page C-2
- Command Descriptions, page C-3
- Disaster Recovery with TFTP Download, page C-3
- Configuration Register, page C-10
- Console Download, page C-12
- Debug Commands, page C-13
- Exiting the ROM Monitor, page C-14

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. Enter your password if prompted.
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 on page C-3. 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
copy            Copy a file-copy [-b <buffer_size>] <src_file> <dst_file>
delete          Delete file(s)-delete <filenames ...>
dir             List files in directories-dir <directory>
dis             display instruction stream
dnld            serial download a program module
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
mkdir           Create dir(s)-mkdir <dirnames ...>
more            Concatenate (type) file(s)-cat <filenames ...>
rename          Rename a file-rename <old_name> <new_name>
repeat          repeat a monitor command
reset           system reset
rmdir           Remove a directory
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> c880-advsecurityk9-mz`
	`9064448 bytes available (10289152 bytes used)`

boot commands	For more information about the ROM monitor boot commands, see *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
WAN GE setting	**FE_PORT**=4
Switch port setting	**FE_PORT=**{0-3}
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***
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 using 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 2400 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

To download a file through TFTP, perform these steps in ROM monitor mode.

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 an 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: 192.168.254.254
TFTP_FILE: c880-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.

Examples

The following shows the example configuration for TFTP support with WAN interface:

```
rommon 1 >
rommon 1 >
rommon 1 > set
PS1=rommon ! >
RTC_STAT=0
GE_SPEED_MODE=4
LICENSE_BOOT_LEVEL=advipservices,all:c800;
WARM_REBOOT=FALSE
TFTP_SERVER=209.165.200.225
IP_SUBNET_MASK=255.255.255.224
DEFAULT_GATEWAY=209.165.200.225
IP_ADDRESS=209.165.200.226
TFTP_FILE=c800-universalk9-mz.SPA.152-3.16.M0.1
FE_PORT=4
?=0
RELOAD_TYPE=1
CRASHINFO=flash:crashinfo_20120406-133436-UTC
BSI=0
RANDOM_NUM=683383170
RET_2_RTS=22:51:49 UTC Fri Jul 13 2012
RET_2_RCALTS=1342219899
rommon 2 >
rommon 2 >
rommon 2 > tftpdnld -r

          IP_ADDRESS: 209.165.200.225
      IP_SUBNET_MASK: 255.255.255.224
     DEFAULT_GATEWAY: 209.165.200.225
         TFTP_SERVER: 209.165.200.225
           TFTP_FILE: c800-universalk9-mz.SPA.152-3.16.M0.1
        TFTP_MACADDR: 00:22:bd:ec:23:f4
    TFTP_DESTINATION: flash:
        TFTP_VERBOSE: Progress
    TFTP_RETRY_COUNT: 18
        TFTP_TIMEOUT: 7200
       TFTP_CHECKSUM: Yes
             FE_PORT: 4
.......
```

```
Receiving c800-universalk9-mz.SPA.152-3.16.M0.1 from 209.165.200.225
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!
File reception completed.
IOS Image Load Test
___________________
Digitally Signed Production Software

Validating checksum.

loading image c800-universalk9-mz.SPA.152-3.16.M0.1
program load complete, entry point: 0x4000000, size: 0x307eeb0
Self decompressing the image :
###########################################################################################
###########################################################################################
###########################################################################################
###########################################################################################
#################################################################### [OK]
*** No sreloc section
Smart Init is enabled
smart init is sizing iomem
                 TYPE      MEMORY_REQ
    Onboard devices &
         buffer pools      0x020ECEC0
------------------------------------------------
               TOTAL:      0x020ECEC0

Rounded IOMEM up to: 32Mb.
Using 3 percent iomem. [32Mb/896Mb]

              Restricted Rights Legend

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

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

Cisco IOS Software, C800 Software (C800-UNIVERSALK9-M), Version 15.2(3.16)M0.1,
MAINTENANCE INTERIM SOFTWARE
Technical Support: http://www.cisco.com/techsupport
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Compiled Thu 07-Jun-12 04:44 by prod_rel_team

WDC is not configured
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.

Installed image archive
Cisco C819HGW+7-A-A-K9 (revision 4.0) with 883788K/33715K bytes of memory.
Processor board ID FAC15455YYZ
4 FastEthernet interfaces
2 Gigabit Ethernet interfaces
1 Serial(sync/async) interface
2 terminal lines
1 Virtual Private Network (VPN) Module
1 Cellular interface
1 cisco Embedded AP (s)
DRAM configuration is 32 bits wide
255K bytes of non-volatile configuration memory.
961128K bytes of ATA System CompactFlash (Read/Write)

Press RETURN to get started!

*Jan  2 00:00:02.391: %IOS_LICENSE_IMAGE_APPLICATION-6-LICENSE_LEVEL: Module name = c800
Next reboot level = advipservices and License = advipservices
*Jul 13 23:00:20.435: %VPN_HW-6-INFO_LOC: Crypto engine: onboard 0  State changed to:
Initialized
*Jul 13 23:00:20.515: %VPN_HW-6-INFO_LOC: Crypto engine: onboard 0  State changed to:
Enabled
*Jul 13 23:00:24.431: c3600_scp_set_dstaddr2_idb(184)add = 0 name is Wlan-GigabitEthernet0
*Jul 13 23:00:41.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface wlan-ap0, changed
state to up
*Jul 13 23:00:41.395: %LINK-3-UPDOWN: Interface GigabitEthernet0, changed state to up
*Jul 13 23:00:41.399: %LINK-3-UPDOWN: Interface Serial0, changed state to down
*Jul 13 23:00:42.187: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state
to down
*Jul 13 23:00:42.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0,
changed state to up
*Jul 13 23:00:42.399: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed
state to down
*Jul 13 23:00:55.915: %SYS-5-CONFIG_I: Configured from memory by console
*Jul 13 23:00:56.159: %FW-6-INIT: Firewall inspection startup completed; beginning
operation.
*Jul 13 23:00:56.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan114, changed
state to down
*Jul 13 23:00:56.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan192, changed
state to down
*Jul 13 23:00:56.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan193, changed
state to down
*Jul 13 23:00:56.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan194, changed
state to down
*Jul 13 23:00:56.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan195, changed
state to down
*Jul 13 23:00:57.011: %SYS-5-RESTART: System restarted --
Cisco IOS Software, C800 Software (C800-UNIVERSALK9-M), Version 15.2(3.16)M0.1,
MAINTENANCE INTERIM SOFTWARE
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thu 07-Jun-12 04:44 by prod_rel_team
*Jul 13 23:00:57.095: %SNMP-5-COLDSTART: SNMP agent on host router is undergoing a cold
start
*Jul 13 23:00:57.103: %SYS-6-BOOTTIME: Time taken to reboot after reload =  558 seconds
*Jul 13 23:00:57.167: %SSH-5-ENABLED: SSH 1.99 has been enabled
*Jul 13 23:00:57.175: %LINK-5-CHANGED: Interface Serial0, changed state to
administratively down
*Jul 13 23:00:57.203: %CRYPTO-6-ISAKMP_ON_OFF: ISAKMP is OFF
*Jul 13 23:00:57.203: %CRYPTO-6-GDOI_ON_OFF: GDOI is OFF
Jul 13 23:00:57.303: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 195.168.100.234 port
514 started - CLI initiated
```

```
Jul 13 23:00:57.303: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 100.100.100.100 port
520 started - CLI initiated
Jul 13 23:00:58.059: %LINK-3-UPDOWN: Interface FastEthernet0, changed state to up
Jul 13 23:00:58.079: %LINK-3-UPDOWN: Interface FastEthernet1, changed state to up
Jul 13 23:00:58.099: %LINK-3-UPDOWN: Interface FastEthernet2, changed state to up
Jul 13 23:00:58.111: %LINK-3-UPDOWN: Interface FastEthernet3, changed state to up
Jul 13 23:00:58.123: %LINK-3-UPDOWN: Interface Wlan-GigabitEthernet0, changed state to up
Jul 13 23:00:59.059: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0,
changed state to down
Jul 13 23:00:59.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1,
changed state to down
Jul 13 23:00:59.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2,
changed state to down
Jul 13 23:00:59.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3,
changed state to down
Jul 13 23:00:59.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Wlan-GigabitEthernet0, changed state to up
Jul 13 23:00:59.883: %DTP-5-TRUNKPORTON: Port Fa3 has become dot1q trunk
Jul 13 23:01:01.091: %LINK-3-UPDOWN: Interface FastEthernet0, changed state to up
Jul 13 23:01:01.231: %LINK-3-UPDOWN: Interface FastEthernet1, changed state to up
Jul 13 23:01:01.259: %LINK-3-UPDOWN: Interface FastEthernet2, changed state to up
Jul 13 23:01:01.375: %LINK-3-UPDOWN: Interface FastEthernet3, changed state to up
Jul 13 23:01:02.091: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0,
changed state to up
Jul 13 23:01:02.527: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1,
changed state to up
Jul 13 23:01:02.527: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2,
changed state to up
Jul 13 23:01:02.527: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3,
changed state to up
Jul 13 23:01:07.811: %SECONDCORE-5-BOOTSTAGE: ROMMON on 2nd core UP
Jul 13 23:01:07.915: %SECONDCORE-5-BOOTSTAGE: AP-BOOTLOADER on 2nd core UP
Jul 13 23:01:09.687: %CISCO800-6-SIM_STATUS: SIM in slot 1 is not present
router>
router>
router>
router>en
router#
router#
router#
router#
Jul 13 23:01:17.063: %CISCO800-2-MODEM_DOWN: Cellular0 modem is now DOWN.sh
router#sh pla
router#sh platform ver
router#sh platform versions

Platform Revisions/Versions :
============================
FPGA       : 1.02   [Val = 0x12]]
Env Rev    : 4.5    [Val = 0x405]
Rework Rev : 00 00 00 00 00 00
CPU Name   : P1021SEC
CPU Ver    : 1.1    [Val = SVR:0x80EC0311]
Core Rev   : 5.1    [Val = PVR:0x80212051]
CCB CLOCK  : 269 MHz

IOS        :
Cisco IOS Software, C800 Software (C800-UNIVERSALK9-M), Version 15.2(3.16)M0.1,
MAINTENANCE INTERIM SOFTWARE
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thu 07-Jun-12 04:44 by prod_rel_team

ROMMON (Readonly) :
```

```
System Bootstrap, Version 15.2(2r)T, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2012 by cisco Systems, Inc.

WLAN AP Boot loader (bundled):
AP802 Boot Loader (AP802-BOOT-M) Version 12.4(25e)JA1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Compiled Wed 30-May-12 03:46 by prod_rel_team

router#
Jul 13 23:01:25.291: %CELLWAN-2-SIM_FAILURE: [Cellular0]: SIM read failed for slot 0
Jul 13 23:01:25.391: %CISCO800-2-MODEM_UP: Cellular0 modem is now UP.
Jul 13 23:01:25.391: %CISCO800-6-SIM_STATUS: SIM in slot 0 is not present
router#
router#
router#
router#
Jul 13 23:01:27.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state
to up
router#
router#
router#
Jul 13 23:01:30.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan114, changed
state to up
Jul 13 23:01:30.263: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan193, changed
state to up
Jul 13 23:01:30.295: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan194, changed
state to up
Jul 13 23:01:30.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan195, changed
state to up
router#
router#
router#
router#
router#sh inv
NAME: "C819HGW+7-A-A-K9", DESCR: "C819HGW+7-A-A-K9 chassis, Hw Serial#: FAC15455YYZ, Hw
Revision: 4.0"
PID: C819HGW+7-A-A-K9  , VID: V01, SN: FAC15455YYZ

NAME: "C819HGW Mother board on Slot 0", DESCR: "C819HGW Mother board"
PID: C819HGW+7-A-A-K9  , VID: V01, SN: FOC15455YYZ

NAME: "Modem 0 on Cellular0", DESCR: "Sierra Wireless Mini Card MC8705 HSPA+R7 modem"
PID: MC8705            , VID: 1.0, SN: 357115040057411

router#
router#
router#
router#
```

Configuration Register

The virtual configuration register is in nonvolatile 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, which is 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 mini-flash 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 want to download a software image or a configuration file to the router over the console port, you must use the ROM monitor **dnld** command.

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. 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, the following error message is displayed:

```
"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:

```
rommon 7> context
CPU context of the most recent exception:
PC  = 0x801111b0  MSR = 0x00009032  CR  = 0x53000035  LR    = 0x80113694
CTR = 0x801065e4  XER = 0xa0006d36  DAR = 0xffffffff  DSISR = 0xffffffff
DEC = 0xffffffff  TBU = 0xffffffff  TBL = 0xffffffff  IMMR  = 0xffffffff
R0  = 0x00000000  R1  = 0x80005ea8  R2  = 0xffffffff  R3    = 0x00000000
R4  = 0x8fab0d76  R5  = 0x80657d00  R6  = 0x80570000  R7    = 0x80570000
R8  = 0x00000000  R9  = 0x80570000  R10 = 0x0000954c  R11   = 0x00000000
R12 = 0x00000080  R13 = 0xffffffff  R14 = 0xffffffff  R15   = 0xffffffff
R16 = 0xffffffff  R17 = 0xffffffff  R18 = 0xffffffff  R19   = 0xffffffff
R20 = 0xffffffff  R21 = 0xffffffff  R22 = 0xffffffff  R23   = 0xffffffff
R24 = 0xffffffff  R25 = 0xffffffff  R26 = 0xffffffff  R27   = 0xffffffff
R28 = 0xffffffff  R29 = 0xffffffff  R30 = 0xffffffff  R31   = 0xffffffff
```

- **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: 40 MB.
Available main memory starts at 0x10000, size 40896KB
IO (packet) memory size: 5 percent of main memory.
NVRAM size: 32KB
```

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 the new configuration 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.

APPENDIX D

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	Who is up or 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