Cisco Secure Router 520 Series Software Configuration Guide

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CONTENTS

Preface

This preface describes the objectives, audience, organization, and conventions of this guide, and describes related documents that have additional information. It contains the following sections:

Objective

This guide provides an overview and explains how to install and connect the wireless and nonwireless Cisco Secure Router 520 Series routers.

For warranty, service, and support information, see the "Cisco One-Year Limited Hardware Warranty Terms" section in the *Readme First for Cisco Secure Router 520 Series* document that was shipped with your router.

Audience

This guide is intended for network administrators whose backgrounds vary from having little or no experience in configuring routers to having a high level of experience.

Organization

This guide is organized into the following chapters and appendix.

Part 1: Getting Started	
Chapter 1, “Basic Router Configuration”	Describes how to configure basic router features and interfaces.
Part 2: Configuring Your Router for Ethernet and DSL Access	
Chapter 2, “Sample Network Deployments”	Provides a road map for Part 2.
Chapter 3, “Configuring PPP over Ethernet with NAT”	Provides instructions on how to configure PPPoE with Network Address Translation (NAT) on your Cisco router.
Chapter 4, “Configuring PPP over ATM with NAT”	Provides instructions on how to configure PPPoA with Network Address Translation (NAT) on your Cisco router.
Chapter 5, “Configuring a LAN with DHCP and VLANs”	Provides instructions on how to configure your Cisco router with multiple VLANs and to have it act as a DHCP server.
Chapter 6, “Configuring a VPN Using Easy VPN and an IPsec Tunnel”	Provides instructions on how to configure a virtual private network (VPN) with a secure IP tunnel using the Cisco Easy VPN.
Chapter 7, “Configuring VPNs Using an IPsec Tunnel and Generic Routing Encapsulation”	Provides instructions on how to configure a VPN with a secure IP tunnel and generic routing encapsulation (GRE).
Chapter 8, “Configuring a Simple Firewall”	Provides instructions on how to configure a basic firewall on your Cisco router.
Chapter 9, “Configuring a Wireless LAN Connection”	Provides instructions on how to configure a wireless LAN connection on your Cisco router.
Part 3: Configuring Additional Features and Troubleshooting	
Chapter 10, “Additional Configuration Options”	Provides a road map for Part 3.
Chapter 11, “Configuring Security Features”	Explains basic configuration of Cisco IOS security features, including firewall and VPN configuration.
Chapter 12, “Troubleshooting”	Provides information on identifying and solving problems with the ADSL line and the telephone interface. Also explains how to recover a lost software password.
Part 4: Reference Information	
Appendix A, “Cisco IOS Software Basic Skills”	Explains what you need to know about Cisco IOS software before you begin to configure it.
Appendix B, “Concepts”	Provides general concept explanations of features.

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

Conventions

This section describes the conventions used in this guide.

Note Means *reader take note*. Notes contain helpful suggestions or references to additional information and material.

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

Warning

IMPORTANT SAFETY INSTRUCTIONS

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Waarschuwing

BELANGRIJKE VEILIGHEIDSINSTRUCTIES

Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van de standaard praktijken om ongelukken te voorkomen. Gebruik het nummer van de verklaring onderaan de waarschuwing als u een vertaling van de waarschuwing die bij het apparaat wordt geleverd, wilt raadplegen.

BEWAAR DEZE INSTRUCTIES

Varoitus

TÄRKEITÄ TURVALLISUUSOHJEITA

Tämä varoitusmerkki merkitsee vaaraa. Tilanne voi aiheuttaa ruumiillisia vammoja. Ennen kuin käsittelet laitteistoa, huomioi sähköpiirien käsittelemiseen liittyvät riskit ja tutustu onnettomuuksien yleisiin ehkäisytapoihin. Turvallisuusvaroitusten käännökset löytyvät laitteen mukana toimitettujen käännettyjen turvallisuusvaroitusten joukosta varoitusten lopussa näkyvien lausuntonumeroiden avulla.

SÄILYTÄ NÄMÄ OHJEET

Attention **IMPORTANTES INFORMATIONS DE SÉCURITÉ**

Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant entraîner des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers liés aux circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions des avertissements figurant dans les consignes de sécurité traduites qui accompagnent cet appareil, référez-vous au numéro de l'instruction situé à la fin de chaque avertissement.

CONSERVEZ CES INFORMATIONS

Warnung **WICHTIGE SICHERHEITSHINWEISE**

Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu Verletzungen führen kann. Machen Sie sich vor der Arbeit mit Geräten mit den Gefahren elektrischer Schaltungen und den üblichen Verfahren zur Vorbeugung vor Unfällen vertraut. Suchen Sie mit der am Ende jeder Warnung angegebenen Anweisungsnummer nach der jeweiligen Übersetzung in den übersetzten Sicherheitshinweisen, die zusammen mit diesem Gerät ausgeliefert wurden.

BEWAHREN SIE DIESE HINWEISE GUT AUF.

Avvertenza **IMPORTANTI ISTRUZIONI SULLA SICUREZZA**

Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di intervenire su qualsiasi apparecchiatura, occorre essere al corrente dei pericoli relativi ai circuiti elettrici e conoscere le procedure standard per la prevenzione di incidenti. Utilizzare il numero di istruzione presente alla fine di ciascuna avvertenza per individuare le traduzioni delle avvertenze riportate in questo documento.

CONSERVARE QUESTE ISTRUZIONI

Advarsel **VIKTIGE SIKKERHETSINSTRUKSJONER**

Dette advarselssymbolet betyr fare. Du er i en situasjon som kan føre til skade på person. Før du begynner å arbeide med noe av utstyret, må du være oppmerksom på farene forbundet med elektriske kretser, og kjenne til standardprosedyrer for å forhindre ulykker. Bruk nummeret i slutten av hver advarsel for å finne oversettelsen i de oversatte sikkerhetsadvarslene som fulgte med denne enheten.

TA VARE PÅ DISSE INSTRUKSJONENE

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você está em uma situação que poderá ser causadora de lesões corporais. Antes de iniciar a utilização de qualquer equipamento, tenha conhecimento dos perigos envolvidos no manuseio de circuitos elétricos e familiarize-se com as práticas habituais de prevenção de acidentes. Utilize o número da instrução fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham este dispositivo.

GUARDE ESTAS INSTRUÇÕES

¡Advertencia! **INSTRUCCIONES IMPORTANTES DE SEGURIDAD**

Este símbolo de aviso indica peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considere los riesgos de la corriente eléctrica y familiarícese con los procedimientos estándar de prevención de accidentes. Al final de cada advertencia encontrará el número que le ayudará a encontrar el texto traducido en el apartado de traducciones que acompaña a este dispositivo.

GUARDE ESTAS INSTRUCCIONES

Varning! **VIKTIGA SÄKERHETSANVISNINGAR**

Denna varningssignal signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanliga förfaranden för att förebygga olyckor. Använd det nummer som finns i slutet av varje varning för att hitta dess översättning i de översatta säkerhetsvarningar som medföljer denna anordning.

SPARA DESSA ANVISNINGAR

Figyelem **FONTOS BIZTONSÁGI ELOÍRÁSOK**

Ez a figyelmezeto jel veszélyre utal. Sérülésveszélyt rejto helyzetben van. Mielott bármely berendezésen munkát végezte, legyen figyelemmel az elektromos áramkörök okozta kockázatokra, és ismerkedjen meg a szokásos balesetvédelmi eljárásokkal. A kiadványban szereplo figyelmeztetések fordítása a készülékhez mellékelt biztonsági figyelmeztetések között található; a fordítás az egyes figyelmeztetések végén látható szám alapján keresheto meg.

ORIZZE MEG EZEKET AZ UTASÍTÁSOKAT!

Предупреждение **ВАЖНЫЕ ИНСТРУКЦИИ ПО СОБЛЮДЕНИЮ ТЕХНИКИ БЕЗОПАСНОСТИ**

Этот символ предупреждения обозначает опасность. То есть имеет место ситуация, в которой следует опасаться телесных повреждений. Перед эксплуатацией оборудования выясните, каким опасностям может подвергаться пользователь при использовании электрических цепей, и ознакомьтесь с правилами техники безопасности для предотвращения возможных несчастных случаев. Воспользуйтесь номером заявления, приведенным в конце каждого предупреждения, чтобы найти его переведенный вариант в переводе предупреждений по безопасности, прилагаемом к данному устройству.

СОХРАНИТЕ ЭТИ ИНСТРУКЦИИ

警告 重要的安全性说明

此警告符号代表危险。您正处于可能受到严重伤害的工作环境中。在您使用设备开始工作之前，必须充分意识到触电的危险，并熟练掌握防止事故发生的标准工作程序。请根据每项警告结尾提供的声明号码来找到此设备的安全性警告说明的翻译文本。

请保存这些安全性说明

警告　安全上の重要な注意事項

「危険」の意味です。人身事故を予防するための注意事項が記述されています。装置の取り扱い作業を行うときは、電気回路の危険性に注意し、一般的な事故防止策に留意してください。警告の各国語版は、各注意事項の番号を基に、装置に付属の「Translated Safety Warnings」を参照してください。

これらの注意事項を保管しておいてください。

주의　중요 안전 지침

이 경고 기호는 위험을 나타냅니다. 작업자가 신체 부상을 일으킬 수 있는 위험한 환경에 있습니다. 장비에 작업을 수행하기 전에 전기 회로와 관련된 위험을 숙지하고 표준 작업 관례를 숙지하여 사고를 방지하십시오. 각 경고의 마지막 부분에 있는 경고문 번호를 참조하여 이 장치와 함께 제공되는 번역된 안전 경고문에서 해당 번역문을 찾으십시오.

이 지시 사항을 보관하십시오.

Aviso　**INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você se encontra em uma situação em que há risco de lesões corporais. Antes de trabalhar com qualquer equipamento, esteja ciente dos riscos que envolvem os circuitos elétricos e familiarize-se com as práticas padrão de prevenção de acidentes. Use o número da declaração fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham o dispositivo.

GUARDE ESTAS INSTRUÇÕES

Advarsel　**VIGTIGE SIKKERHEDSANVISNINGER**

Dette advarselssymbol betyder fare. Du befinder dig i en situation med risiko for legemesbeskadigelse. Før du begynder arbejde på udstyr, skal du være opmærksom på de involverede risici, der er ved elektriske kredsløb, og du skal sætte dig ind i standardprocedurer til undgåelse af ulykker. Brug erklæringsnummeret efter hver advarsel for at finde oversættelsen i de oversatte advarsler, der fulgte med denne enhed.

GEM DISSE ANVISNINGER

تحذير　**إرشادات الأمان الهامة**

يوضح رمز التحذير هذا وجود خطر. وهذا يعني أنك متواجد في مكان قد ينتج عنه التعرض لإصابات. قبل بدء العمل، احذر مخاطر التعرض للصدمات الكهربائية وكن على علم بالإجراءات القياسية للحيلولة دون وقوع أي حوادث. استخدم رقم البيان الموجود في أخر كل تحذير لتحديد مكان ترجمته داخل تحذيرات الأمان المترجمة التي تأتي مع الجهاز.
قم بحفظ هذه الإرشادات

Upozorenje

VAŽNE SIGURNOSNE NAPOMENE

Ovaj simbol upozorenja predstavlja opasnost. Nalazite se u situaciji koja može prouzročiti tjelesne ozljede. Prije rada s bilo kojim uređajem, morate razumjeti opasnosti vezane uz električne sklopove, te biti upoznati sa standardnim načinima izbjegavanja nesreća. U prevedenim sigurnosnim upozorenjima, priloženima uz uređaj, možete prema broju koji se nalazi uz pojedino upozorenje pronaći i njegov prijevod.

SAČUVAJTE OVE UPUTE

Upozornění

DŮLEŽITÉ BEZPEČNOSTNÍ POKYNY

Tento upozorňující symbol označuje nebezpečí. Jste v situaci, která by mohla způsobit nebezpečí úrazu. Před prací na jakémkoliv vybavení si uvědomte nebezpečí související s elektrickými obvody a seznamte se se standardními opatřeními pro předcházení úrazům. Podle čísla na konci každého upozornění vyhledejte jeho překlad v přeložených bezpečnostních upozorněních, která jsou přiložena k zařízení.

USCHOVEJTE TYTO POKYNY

Προειδοποίηση

ΣΗΜΑΝΤΙΚΕΣ ΟΔΗΓΙΕΣ ΑΣΦΑΛΕΙΑΣ

Αυτό το προειδοποιητικό σύμβολο σημαίνει κίνδυνο. Βρίσκεστε σε κατάσταση που μπορεί να προκαλέσει τραυματισμό. Πριν εργαστείτε σε οποιοδήποτε εξοπλισμό, να έχετε υπόψη σας τους κινδύνους που σχετίζονται με τα ηλεκτρικά κυκλώματα και να έχετε εξοικειωθεί με τις συνήθεις πρακτικές για την αποφυγή ατυχημάτων. Χρησιμοποιήστε τον αριθμό δήλωσης που παρέχεται στο τέλος κάθε προειδοποίησης, για να εντοπίσετε τη μετάφρασή της στις μεταφρασμένες προειδοποιήσεις ασφαλείας που συνοδεύουν τη συσκευή.

ΦΥΛΑΞΤΕ ΑΥΤΕΣ ΤΙΣ ΟΔΗΓΙΕΣ

אזהרה

הוראות בטיחות חשובות

סימן אזהרה זה מסמל סכנה. אתה נמצא במצב העלול לגרום לפציעה. לפני שתעבוד עם ציוד כלשהו, עליך להיות מודע לסכנות הכרוכות במעגלים חשמליים ולהכיר את הנהלים המקובלים למניעת תאונות. השתמש במספר ההוראה המסופק בסופה של כל אזהרה כד לאתר את התרגום באזהרות הבטיחות המתורגמות שמצורפות להתקן.

שמור הוראות אלה

Opomena

ВАЖНИ БЕЗБЕДНОСНИ НАПАТСТВИЈА

Симболот за предупредување значи опасност. Се наоѓате во ситуација што може да предизвика телесни повреди. Пред да работите со опремата, бидете свесни за ризикот што постои кај електричните кола и треба да ги познавате стандардните постапки за спречување на несреќни случаи. Искористете го бројот на изјавата што се наоѓа на крајот на секое предупредување за да го најдете неговиот период во преведените безбедносни предупредувања што се испорачани со уредот.

ЧУВАЈТЕ ГИ ОВИЕ НАПАТСТВИЈА

Ostrzeżenie

WAŻNE INSTRUKCJE DOTYCZĄCE BEZPIECZEŃSTWA

Ten symbol ostrzeżenia oznacza niebezpieczeństwo. Zachodzi sytuacja, która może powodować obrażenia ciała. Przed przystąpieniem do prac przy urządzeniach należy zapoznać się z zagrożeniami związanymi z układami elektrycznymi oraz ze standardowymi środkami zapobiegania wypadkom. Na końcu każdego ostrzeżenia podano numer, na podstawie którego można odszukać tłumaczenie tego ostrzeżenia w dołączonym do urządzenia dokumencie z tłumaczeniami ostrzeżeń.

NINIEJSZE INSTRUKCJE NALEŻY ZACHOWAĆ

Upozornenie

DÔLEŽITÉ BEZPEČNOSTNÉ POKYNY

Tento varovný symbol označuje nebezpečenstvo. Nachádzate sa v situácii s nebezpečenstvom úrazu. Pred prácou na akomkoľvek vybavení si uvedomte nebezpečenstvo súvisiace s elektrickými obvodmi a oboznámte sa so štandardnými opatreniami na predchádzanie úrazom. Podľa čísla na konci každého upozornenia vyhľadajte jeho preklad v preložených bezpečnostných upozorneniach, ktoré sú priložené k zariadeniu.

USCHOVAJTE SI TENTO NÁVOD

Related Documentation

The Cisco Secure Router 520 Series product is shipped with a minimal set of printed documentation. Additional product documentation is available on Cisco.com.

In addition to the *Cisco Secure Router 520 Series Software Configuration Guide* (this document), the Cisco Secure Router 520 Series documentation set includes the following documents.

The following documentation is shipped with the product:

- For warranty, service, and support information, see the *Readme First for Cisco Secure Router 520 Series* document.
- *Cisco Regulatory Compliance and Safety Information Roadmap*

The following Cisco Secure Router 520 Series product documentation is available on Cisco.com:

- *Cisco Secure Router 520 Series Hardware Installation Guide*

  http://www.cisco.com/en/US/docs/routers/access/500/520/hardware/installation/guide/SR_520_HIguide.html
- *Regulatory Compliance and Safety Information for Cisco Secure Router 500 Series*

  http://www.cisco.com/en/US/docs/routers/access/500/520/rcsi/500_rcsi.html

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.

PART 1

Getting Started

CHAPTER 1

Basic Router Configuration

The Cisco Secure Router 520 Series routers are designed for small businesses with up to 50 users and teleworkers who want secure connectivity to corporate LANs and to the Internet. These routers provide advanced security features that include secure Virtual Private Network (VPN) access and comprehensive threat defense with Cisco IOS Firewall, Intrusion Prevention Solution (IPS), and URL filtering. The Cisco Secure Router 520 Series routers also provide dynamic routing and advanced quality of service (QoS) features.

The Cisco Secure Router 520 Series routers complement the Cisco Unified Communications 500 Series router and the Cisco Smart Business Communications System (SBCS) portfolio. As part of the SBCS portfolio, the Cisco Secure Router 520 Series routers deliver a common user experience through integration with the Cisco Configuration Assistant, Cisco Smart Assist, Cisco Monitor Manager, and Cisco Monitor Director.

This chapter provides procedures for configuring the basic parameters of your Cisco router, including global parameter settings, routing protocols, interfaces, and command-line access using the CLI. It also describes the default configuration at startup.

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

This chapter contains the following sections:

- Viewing the Default Configuration
- Information Needed for Customizing the Default Parameters
- Interface Port Labels
- Configuring Basic Parameters
- Configuring Static Routes
- Configuring Dynamic Routes

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

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

Viewing the Default Configuration

When the router first boots up, some basic configuration has already been performed. All of the LAN and WAN interfaces have been created, console and VTY ports are configured, and the inside interface for Network Address Translation has been assigned.

To view the default configuration, follow these steps:

Step 1 Use the default username **cisco** and the default password **cisco** to enter the privileged EXEC mode.

Step 2 Use the **show running-config** command to view the initial configuration.

Information Needed for Customizing the Default Parameters

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

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

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

    AAL5MUX PPP—With this type of encapsulation, you need to determine the PPP-related configuration items.
- If you plan to connect over an ADSL line:

– Order the appropriate line from your public telephone service provider. Ensure that the ADSL signaling type is DMT (also called ANSI T1.413) or DMT Issue 2.

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

Interface Port Labels

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

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

Router	Interface	Port Label
Cisco Secure Router 520 Ethernet-to-Ethernet routers	Fast Ethernet LAN	FE0–FE3
	Fast Ethernet WAN	FE4
	Wireless LAN	None (antenna is not labeled)
Cisco Secure Router 520 ADSL-over-POTS routers	Fast Ethernet LAN	LAN (top), FE0–FE3 (bottom)
	ATM WAN	ADSLoPOTS
	Wireless LAN	None (antenna is not labeled)
Cisco Secure Router 520 ADSL-over-ISDN routers	Fast Ethernet LAN	LAN (top), FE0–FE3 (bottom)
	ATM WAN	ADSLoISDN
	Wireless LAN	None (antenna is not labeled)

Configuring Basic Parameters

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

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

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

Configure Global Parameters

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

	Command	Purpose

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

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

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

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

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

Configure Fast Ethernet LAN Interfaces

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

Configure WAN Interfaces

The Cisco Secure Router 520 Ethernet-to-Ethernet routers have one Fast Ethernet interface for WAN connection. The Cisco Secure Router 520 ADSL-over-POTS and Cisco Secure Router 520 ADSL-over-ISDN routers have one ATM interface for WAN connection.

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

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

Configure the Fast Ethernet WAN Interface

This procedure applies only to the Cisco Secure Router 520 Ethernet-to-Ethernet routers. Perform these steps to configure the Fast Ethernet interface, beginning in global configuration mode:

	Command	Purpose

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

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

Configure the ATM WAN Interface

This procedure applies only to the Cisco Secure Router 520 ADSL-over-POTS and Cisco Secure Router 520 ADSL-over-ISDN routers.

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

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface atm0`
	`Router(config-if)#`
		Identifies and enters the configuration mode for an ATM interface.

Step 2	**ip address** *ip-address mask*
	
	Example:
	`Router(config-if)# ip address 200.200.100.1 255.255.255.0`
	`Router(config-if)#`
		Sets the IP address and subnet mask for the ATM interface.

Step 3	**no shutdown**
	
	Example:
	`Router(config-if)# no shutdown`
	`Router(config-if)#`
		Enables the ATM 0 interface.

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

Configure the Wireless Interface

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

Configuring a Loopback Interface

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

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

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

	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.

Configuration Example

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

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

Verifying Your Configuration

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

```
Router# show interface loopback 0
Loopback0 is up, line protocol is up
  Hardware is Loopback
  Internet address is 200.200.100.1/24
  MTU 1514 bytes, BW 8000000 Kbit, DLY 5000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation LOOPBACK, loopback not set
  Last input never, output never, output hang never
```

```
Last clearing of "show interface" counters never
Queuing strategy: fifo
Output queue 0/0, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   0 packets input, 0 bytes, 0 no buffer
   Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
   0 packets output, 0 bytes, 0 underruns
   0 output errors, 0 collisions, 0 interface resets
   0 output buffer failures, 0 output buffers swapped out
```

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

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

Configuring Command-Line Access to the Router

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

	Command	Purpose

Step 1	**line** [**aux** | **console** | **tty** | **vty**] *line-number*
	
	Example:
	`Router(config)# line console 0`
	`Router(config-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-line)# 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.

	Command	Purpose

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

Step 6	**line** [**aux** | **console** | **tty** | **vty**] *line-number*
	
	Example:
	`Router(config)# line vty 0 4`
	`Router(config-line)#`
		Specifies a virtual terminal for remote console access.

Step 7	**password** *password*
	
	Example:
	`Router(config-line)# password aldf2ad1`
	`Router(config-line)#`
		Specifies a unique password for the virtual terminal line.

Step 8	**login**
	
	Example:
	`Router(config-line)# login`
	`Router(config-line)#`
		Enables password checking at the virtual terminal session login.

Step 9	**end**
	
	Example:
	`Router(config-line)# end`
	`Router#`
		Exits line configuration mode, and returns to privileged EXEC mode.

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

Configuration Example

The following configuration shows the command-line access commands.

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

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

Configuring Static Routes

Static routes provide fixed routing paths through the network. They are manually configured on the router. If the network topology changes, the static route must be updated with a new route. Static routes are private routes unless they are redistributed by a routing protocol. Configuring static routes on the Cisco Secure Router 520 Series router is optional.

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

	Command	Purpose

Step 1	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]}
	
	Example:
	`Router(config)# ip route 192.168.0.0 255.255.0.0 10.10.10.2`
	`Router(config)#`
		Specifies the static route for the IP packets.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS IP Command Reference, Volume 2 of 4: Routing Protocols*.

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

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

Configuration Example

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

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

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

Verifying Your Configuration

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

You should see verification output similar to the following example.

```
Router# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external,
       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), to learn routes dynamically. You can configure either of these routing protocols on your router.

Configuring RIP

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

	Command	Task

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

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

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

	Command	Task

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

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

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

Configuration Example

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

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

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

Verifying Your Configuration

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

```
Router# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external,
       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
```

PART 2

Configuring Your Router for Ethernet and DSL Access

CHAPTER 2

Sample Network Deployments

This part of the software configuration guide presents a variety of possible Ethernet and Digital Subscriber Line (DSL)—based network configurations using the Cisco Secure Router 520 Series router. Each scenario is described with a network topology, a step-by-step procedure that is used to implement the network configuration, and a configuration example that shows the results of the configuration. The Cisco Secure Router 520 Ethernet-to-Ethernet routers can be used in the Ethernet-based scenarios and the Cisco Secure Router 520 ADSL-over-POTS and Cisco Secure Router 520 ADSL-over-ISDN routers can be used in the DSL-based scenarios.

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

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

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

For Ethernet-Based Network Deployments

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

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

For DSL-Based Network Deployments

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

- Chapter 4, “Configuring PPP over ATM with NAT”
- Chapter 5, “Configuring a LAN with DHCP and VLANs”
- Chapter 6, “Configuring a VPN Using Easy VPN and an IPsec Tunnel”

- Chapter 7, “Configuring VPNs Using an IPsec Tunnel and Generic Routing Encapsulation”
- Chapter 8, “Configuring a Simple Firewall”

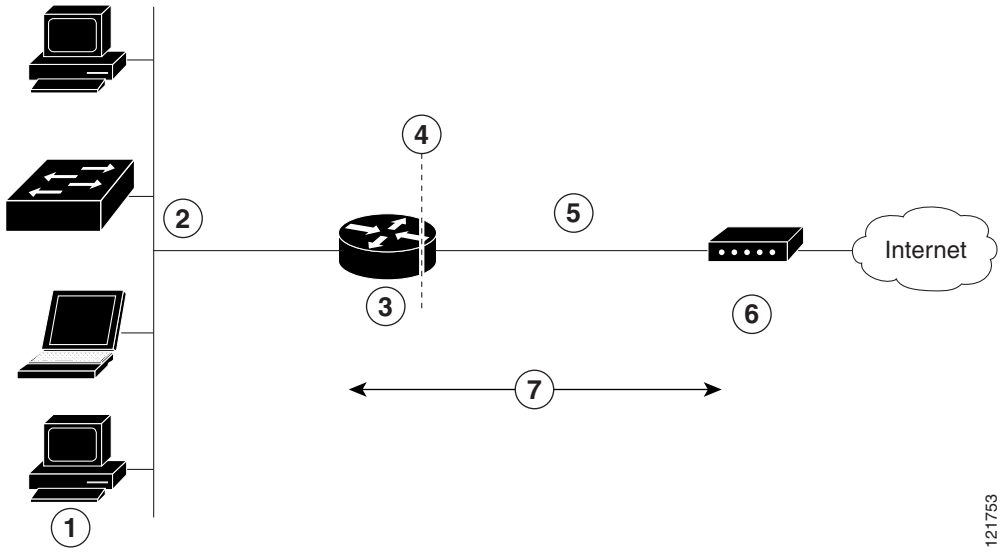
CHAPTER 3

Configuring PPP over Ethernet with NAT

The Cisco Secure Router 520 Ethernet-to-Ethernet routers support Point-to-Point Protocol over Ethernet (PPPoE) clients and network address translation (NAT).

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

Figure 3-1 PPP over Ethernet with NAT



1	Multiple networked devices—Desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (inside interface for NAT)
3	PPPoE client—Cisco Secure Router 520 Ethernet-to-Ethernet router
4	Point at which NAT occurs
5	Fast Ethernet WAN interface (outside interface for NAT)
6	Cable modem or other server (for example, a Cisco 6400 server) that is connected to the Internet
7	PPPoE session between the client and a PPPoE server

PPPoE

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

A PPPoE session is initiated on the client side by the Cisco Secure Router 520 Ethernet-to-Ethernet routers. An established PPPoE client session can be terminated in one of two ways:

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

NAT

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

Configuration Tasks

Perform the following tasks to configure this network scenario:

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

An example showing the results of these configuration tasks is shown in the "Configuration Example" section on page 3-8.

Configure the Virtual Private Dialup Network Group Number

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

Complete the following steps to configure a VPDN, starting from the global configuration mode. See the "Configure Global Parameters" section on page 1-4 for details about entering this mode.

	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.

	Command or Action	Purpose

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:

	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.

	Command	Purpose

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

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

Configure the Dialer Interface

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

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

	Command	Purpose

Step 1	**interface dialer** *dialer-rotary-group-number*
	
	Example:
	`Router(config)# interface dialer 0`
	`Router(config-if)#`
		Creates a dialer interface (numbered 0 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.

	Command	Purpose

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

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

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

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

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

Step 10	**ip route** *prefix mask* {*interface-type interface-number*}
	
	Example:
	`Router(config)# ip route 10.10.25.2 255.255.255.255 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 the *Cisco IOS IP Command Reference, Volume 2; Routing Protocols*.

Configure Network Address Translation

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

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

	Command	Purpose

Step 1	**ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
	
	Example:
	`Router(config)# ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 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 1:
	`Router(config)# ip nat inside source list 1 interface dialer 0 overload`
	
	or
	
	Example 2:
	`Router(config)# ip nat inside source list acl1 pool pool1`
		Enables dynamic translation of addresses on the inside interface.
		
		The first example shows the addresses permitted by the access list *1* to be translated to one of the addresses specified in the dialer interface *0*.
		
		The second example shows the addresses permitted by access list *acl1* to be translated to one of the addresses specified in the NAT pool *pool1*.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 3	**interface** *type number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config-if)#`
		Enters configuration mode for the VLAN (on which the Fast Ethernet LAN interfaces [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 the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

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

	Command	Purpose

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

Step 7	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 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 the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

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

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

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

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

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

Configuration Example

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

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

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

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

```
!
vpdn enable
vpdn-group 1
request-dialin
protocol pppoe
!
interface vlan 1
ip address 192.168.1.1 255.255.255.0
no ip directed-broadcast (default)
ip nat inside
!
interface FastEthernet 4
ip address 192.1.12.2 255.255.255.0
no ip directed-broadcast (default)
ip nat outside
!
interface dialer 1
ip address negotiated
ppp authentication chap
dialer pool 1
dialer-group 1
!
dialer-list 1 protocol ip permit
ip nat inside source list 1 interface dialer 0 overload
ip classless (default)
ip route 10.10.25.2 0.255.255.255 dialer 0
!
```

Verifying Your Configuration

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

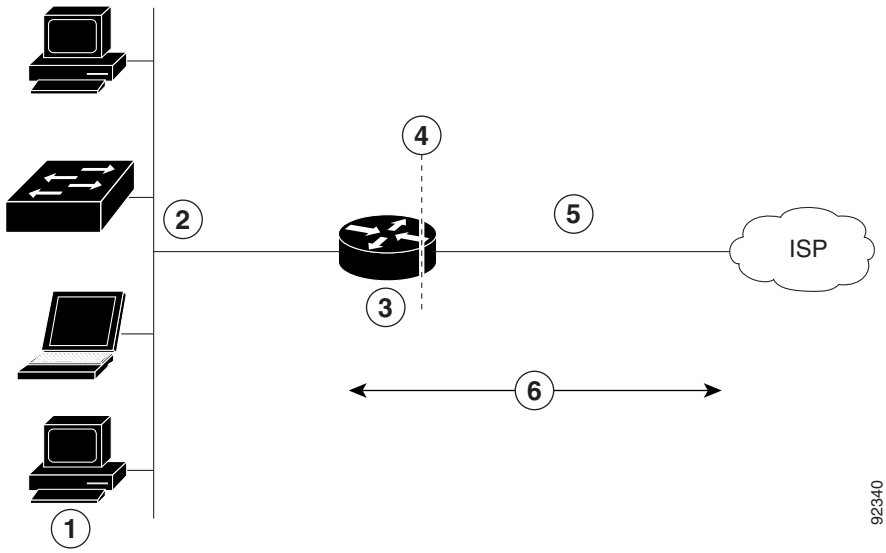
CHAPTER 4

Configuring PPP over ATM with NAT

The Cisco Secure Router 520 ADSL-over-POTS and Cisco Secure Router 520 ADSL-over-ISDN routers support Point-to-Point Protocol over Asynchronous Transfer Mode (PPPoA) clients and network address translation (NAT).

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

Figure 4-1 PPP over ATM with NAT



1	Small business with multiple networked devices—desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (inside interface for NAT, 192.168.1.1/24)
3	PPPoA Client—Cisco Secure Router 520 ADSL-over-POTS or Cisco Secure Router 520 ADSL-over-ISDN router
4	Point at which NAT occurs
5	ATM WAN interface (outside interface for NAT)
6	PPPoA session between the client and a PPPoA server at the ISP

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

- Asymmetric digital subscriber line (ADSL) over plain old telephone service (POTS) using the Cisco Secure Router 520 ADSL-over-POTS routers
- ADSL over integrated services digital network (ISDN) using the Cisco Secure Router 520 ADSL-over-ISDN routers

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

PPPoA

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

A PPPoA session is initiated on the client side by the Cisco Secure Router 520 Series router.

NAT

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

Configuration Tasks

Perform the following tasks to configure this network scenario:

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

An example showing the results of these configuration tasks is shown in the "Configuration Example" section on page 4-9.

Configure the Dialer Interface

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

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

	Command	Purpose

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

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

Step 3	**ip mtu** *bytes*
	
	Example:
	`Router(config-if)# ip mtu 1492`
	`Router(config-if)#`
		Sets the size of the IP maximum transmission unit (MTU). The default minimum is 128 bytes. The maximum for ATM 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.
		The example applies the Challenge Handshake Authentication Protocol (CHAP).
		For details about this command and additional parameters that can be set, see the *Cisco IOS Security Command Reference.*

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

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

	Command	Purpose

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

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

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

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

Configure the ATM WAN Interface

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

	Command	Purpose

Step 1	**interface** *type number*
	
	Example:
	`Router(config)# interface atm 0`
	`Router(config-if)#`
		Enters interface configuration mode for the ATM interface (labeled ADSLoPOTS).
		
		Note This interface was initially configured during basic router configuration. See the "Configure WAN Interfaces" section on page 1-4.

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

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

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

	Command	Purpose

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

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

Configure DSL Signaling Protocol

DSL signaling must be configured on the ATM interface for connection to your ISP. The Cisco Secure Router 520 ADSL-over-POTS routers support ADSL signaling over POTS and the Cisco Secure Router 520 ADSL-over-ISDN routers support ADSL signaling over ISDN. To configure the DSL signaling protocol, see the "Configuring ADSL" section on page 4-6.

Configuring ADSL

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

Table 4-1 Default ADSL Configuration

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

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

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

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

Verify the Configuration

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

Configure Network Address Translation

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

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

	Command	Purpose

Step 1	**ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
	
	Example:
	`Router(config)# ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 255.255.255.0`
	`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 1:
	`Router(config)# ip nat inside source list 1 interface dialer 0 overload`
	
	or
	
	Example 2:
	`Router(config)# ip nat inside source list acl1 pool pool1`
		Enables dynamic translation of addresses on the inside interface.
		
		The first example shows the addresses permitted by the access list *1* to be translated to one of the addresses specified in the dialer interface *0*.
		
		The second example shows the addresses permitted by access list *acl1* to be translated to one of the addresses specified in the NAT pool *pool1*.
		
		For details about this command and additional parameters that can be set, as well as information about enabling static translation, see the *Cisco IOS IP Command Reference, Volume 1 of 4: Addressing and Services*.

Step 3	**interface** *type number*
	
	Example:
	`Router(config)# interface vlan 1`
	`Router(config-if)#`
		Enters configuration mode for the VLAN (on which the Fast Ethernet LAN interfaces [FE0–FE3] reside) to be the inside interface for NAT.

	Command	Purpose

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

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

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

Step 7	**interface** *type number*
	
	Example:
	`Router(config)# interface atm 0`
	`Router(config-if)#`
		Enters configuration mode for the ATM WAN interface (ATM0) to be the outside interface for NAT.

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

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

	Command	Purpose

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

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

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

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

Configuration Example

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

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

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

```
!
interface Vlan1
 ip address 192.168.1.1 255.255.255.0
 ip nat inside
 ip virtual-reassembly (default)
!
interface ATM0
 no ip address
 ip nat outside
 ip virtual-reassembly
 no atm ilmi-keepalive
 pvc 8/35
  encapsulation aal5mux ppp dialer
  dialer pool-member 1
 !
 dsl operating-mode auto
!
interface Dialer0
 ip address negotiated
```

```
 ip mtu 1492
 encapsulation ppp
 dialer pool 1
 dialer-group 1
 ppp authentication chap
!
ip classless (default)
!
ip nat pool pool1 192.168.1.0 192.168.2.0 netmask 0.0.0.255
ip nat inside source list 1 interface Dialer0 overload
!
access-list 1 permit 192.168.1.0 0.0.0.255
dialer-list 1 protocol ip permit

ip route 10.10.25.2 0.255.255.255 dialer 0
!
```

Verifying Your Configuration

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

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

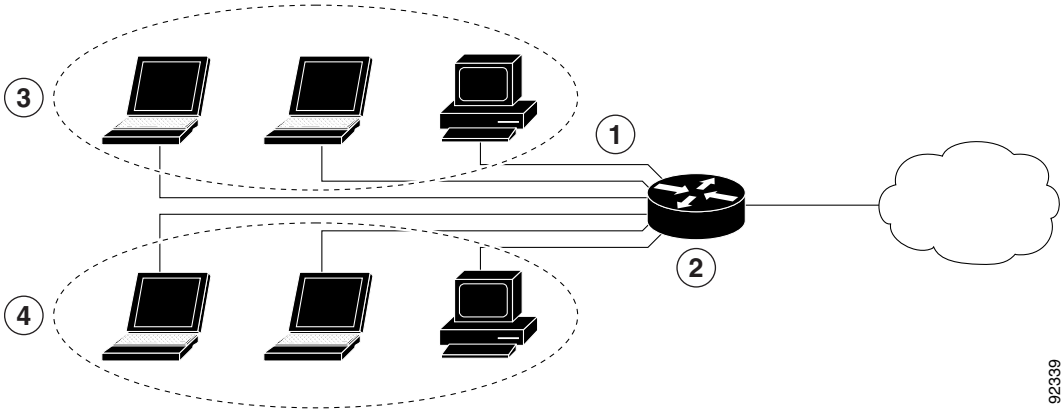
CHAPTER 5

Configuring a LAN with DHCP and VLANs

The Cisco Secure Router 520 Series routers support clients on both physical LANs and virtual LANs (VLANs). The routers can use the Dynamic Host Configuration Protocol (DHCP) to enable automatic assignment of IP configurations for nodes on these networks.

Figure 5-1 shows a typical deployment scenario with two physical LANs connected by the router and two VLANs.

Figure 5-1 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 Secure Router 520 Series router—connected to the Internet
3	VLAN 1
4	VLAN 2

DHCP

DHCP, which is described in RFC 2131, uses a client/server router for address allocation. As an administrator, you can configure your Cisco Secure Router 520 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 Secure Router 520 Series 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
- Configure VLANs

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

Configure DHCP

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

	Command	Purpose

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

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

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

	Command	Purpose

Step 4	**ip dhcp pool** *name*
	
	Example:
	`Router(config)# ip dhcp pool dpool1`
	`Router(dhcp-config)#`
		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(dhcp-config)# network 10.10.0.0 255.255.255.0`
	`Router(dhcp-config)#`
		Defines subnet number (IP) address for the DHCP address pool, optionally including the mask.

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

Step 7	**default-router** *address* [*address2...address8*]
	
	Example:
	`Router(dhcp-config)# default-router 10.10.10.10`
	`Router(dhcp-config)#`
		Specifies up to 8 default routers for a DHCP client.

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

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

Step 10	**exit**
	
	Example:
	`Router(dhcp-config)# 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 privileged EXEC mode:

	Command	Purpose

Step 1	**vlan database**
	
	Example:
	`Router# vlan database`
	`Router(vlan)#`
		Enters VLAN configuration mode.

Step 2	**vlan** *vlan-id* [**media** *type*] [**name** *vlan-name*]
	
	Example:
	`Router(vlan)# vlan 2 media ethernet name VLAN0002`
	`VLAN 2 added:`
	`  Name: VLAN0002`
	`  Media type: ETHERNET`
	`Router(vlan)# vlan 3 media ethernet name red-vlan`
	`VLAN 3 added:`
	`  Name: red-vlan`
	`  Media type: ETHERNET`
	`Router(vlan)#`
		Adds VLANs, with identifiers ranging from 2 to 1001.
		
		For details about this command and additional parameters that can be set, see the *Cisco IOS Switching Services Command Reference*.

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

Assign a Switch Port to a VLAN

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

	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 6

Configuring a VPN Using Easy VPN and an IPsec Tunnel

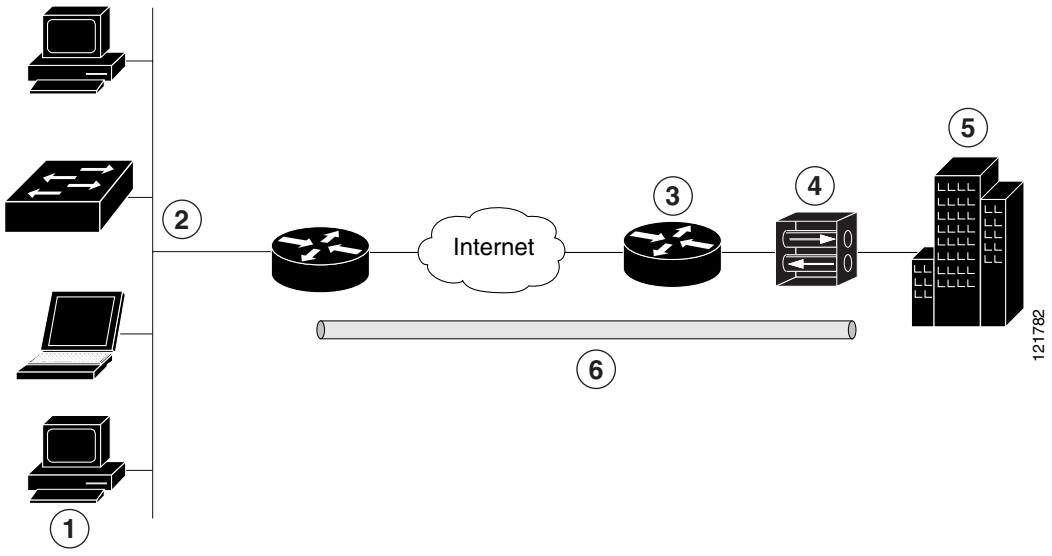
The Cisco Secure Router 520 Series routers support the creation of Virtual Private Networks (VPNs).

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

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

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

Figure 6-1 Remote Access VPN Using IPsec Tunnel



1	Remote, networked users
2	VPN client—Cisco Secure Router 520 Series router
3	Router—Providing the corporate office network access

4	VPN server—Easy VPN server; for example, a Cisco Adaptive Security Appliance (ASA) Series concentrator with outside interface address 210.110.101.1
5	Corporate office with a network address of 10.1.1.1
6	IPsec tunnel

Cisco Easy VPN

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

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

The Cisco Easy VPN client feature can be configured in one of two modes—client mode or network extension mode. Client mode is the default configuration and allows only devices at the client site to access resources at the central site. Resources at the client site are unavailable to the central site. Network extension mode allows users at the central site (where the Cisco ASA 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 Secure Router 520 Series router. When the IPsec client initiates the VPN tunnel connection, the IPsec server pushes the IPsec policies to the IPsec client and creates the corresponding VPN tunnel connection.

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

Configuration Tasks

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

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

An example showing the results of these configuration tasks is provided in the "Configuration Example" section on page 6-10.

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

Note The examples shown in this chapter refer only to the endpoint configuration on the Cisco Secure Router 520 Series 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:

	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.

	Command or Action	Purpose

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

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

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

Configure Group Policy Information

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

	Command or Action	Purpose

Step 1	**crypto isakmp client configuration group** {**group-name** | **default**}
	
	Example:
	`Router(config)# crypto isakmp client configuration group rtr-remote`
	`Router(config-isakmp-group)#`
		Creates an IKE policy group 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.

	Command or Action	Purpose

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

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

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

Apply Mode Configuration to the Crypto Map

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

	Command or Action	Purpose

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

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

Enable Policy Lookup

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

	Command or Action	Purpose

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

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

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

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

Configure IPsec Transforms and Protocols

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

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

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

	Command or Action	Purpose

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

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

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

Configure the IPsec Crypto Method and Parameters

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

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

	Command or Action	Purpose

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

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

	Command or Action	Purpose

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

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

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

Apply the Crypto Map to the Physical Interface

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

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

	Command or Action	Purpose

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

	Command or Action	Purpose

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

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

Create an Easy VPN Remote Configuration

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

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

	Command or Action	Purpose

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

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

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

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

	Command or Action	Purpose

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

Step 6	**interface** *type number*
	
	Example:
	`Router(config)# interface fastethernet 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 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

```
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
!
```

CHAPTER 7

Configuring VPNs Using an IPsec Tunnel and Generic Routing Encapsulation

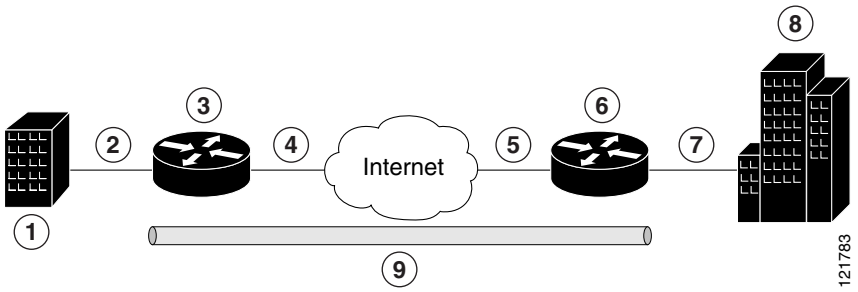
The Cisco Secure Router 520 Series routers support the creation of virtual private networks (VPNs).

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

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

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

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



1	Branch office containing multiple LANs and VLANs
2	Fast Ethernet LAN interface—With address 192.168.0.0/16 (also the inside interface for NAT)
3	VPN client—Cisco Secure Router 520 Series routers
4	Fast Ethernet or ATM interface—With address 200.1.1.1 (also the outside interface for NAT)
5	LAN interface—Connects to the Internet; with outside interface address of 210.110.101.1
6	VPN client—Another router, which controls access to the corporate network
7	LAN interface—Connects to the corporate network, with inside interface address of 10.1.1.1
8	Corporate office network
9	IPsec tunnel with GRE

GRE Tunnels

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

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

VPNs

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

Configuration Tasks

Perform the following tasks to configure this network scenario:

- Configure a VPN
- Configure a GRE Tunnel

A configuration example showing the results of these configuration tasks is provided in the "Configuration Example" section on page 7-9.

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

Configure a VPN

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

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

Configure the IKE Policy

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

	Command or Action	Purpose

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

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

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

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

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

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

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

Configure Group Policy Information

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

	Command or Action	Purpose

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

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

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

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

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

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

Enable Policy Lookup

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

	Command or Action	Purpose

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

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

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

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

Configure IPsec Transforms and Protocols

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

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

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

	Command or Action	Purpose

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

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

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

Configure the IPsec Crypto Method and Parameters

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

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

	Command or Action	Purpose

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

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

	Command or Action	Purpose

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

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

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

Apply the Crypto Map to the Physical Interface

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

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

	Command or Action	Purpose

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

	Command or Action	Purpose

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

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

Configure a GRE Tunnel

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

	Command or Action	Purpose

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

Step 2	**ip address** *ip-address subnet mask*
	
	Example:
	`Router(config-if)# ip address 10.62.1.193 255.255.255.255`
	`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.

	Command or Action	Purpose

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

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

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

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

Step 9	**exit**
	
	Example:
	`Router(config-ext-nacl)# 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 interface.
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 8

Configuring a Simple Firewall

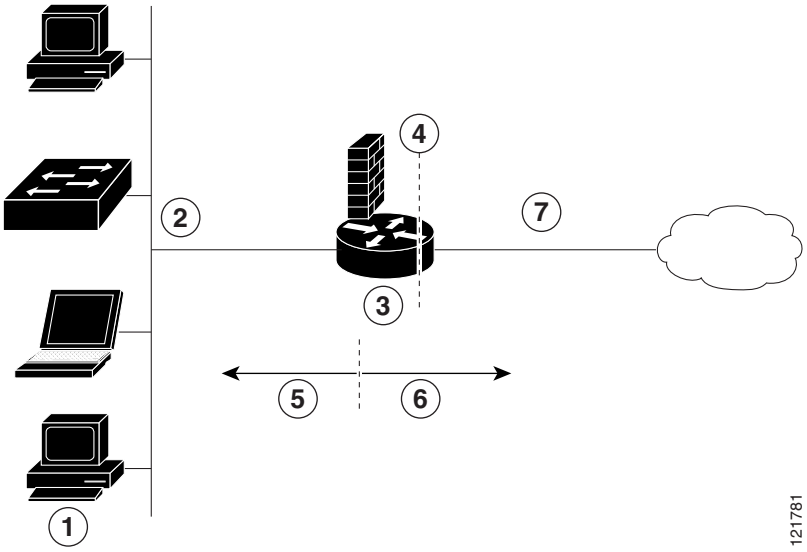
The Cisco Secure Router 520 Series routers support network traffic filtering by means of access lists. The routers also support packet inspection and dynamic temporary access lists by means of Context-Based Access Control (CBAC).

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

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

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

Figure 8-1 Router with Firewall Configured



1	Multiple networked devices—Desktops, laptop PCs, switches
2	Fast Ethernet LAN interface (the inside interface for NAT)
3	PPPoE or PPPoA client and firewall implementation—Cisco Secure Router 520 Series router
4	Point at which NAT occurs
5	Protected network
6	Unprotected network
7	Fast Ethernet or ATM WAN interface (the outside interface for NAT)

In the configuration example that follows, the firewall is applied to the outside WAN interface (FE4) and protects the Fast Ethernet LAN on FE0 by filtering and inspecting all traffic entering the router on the Fast Ethernet WAN interface FE4. Note that in this example, the network traffic originating from the corporate network, network address 10.1.1.0, is considered safe traffic and is not filtered.

Configuration Tasks

Perform the following tasks to configure this network scenario:

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

A configuration example that shows the results of these configuration tasks is provided in the "Configuration Example" section on page 8-5.

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

Configure Access Lists

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

	Command	Purpose

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

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

Configure Inspection Rules

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

	Command or Action	Purpose

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

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

Apply Access Lists and Inspection Rules to Interfaces

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

	Command	Purpose

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

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

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

	Command	Purpose

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

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

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

Configuration Example

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

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

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

```
!
! Firewall inspection is set up for all TCP and UDP traffic as well as
! specific application protocols as defined by the security policy.
ip inspect name firewall tcp
ip inspect name firewall udp
ip inspect name firewall rtsp
ip inspect name firewall h323
ip inspect name firewall netshow
ip inspect name firewall ftp
ip inspect name firewall sqlnet
!
interface vlan 1! This is the internal home network.
ip inspect firewall in ! Inspection examines outbound traffic.
    no cdp enable
!
interface fastethernet 4! FE4 is the outside or Internet-exposed interface.
! 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
!
! 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 9

Configuring a Wireless LAN Connection

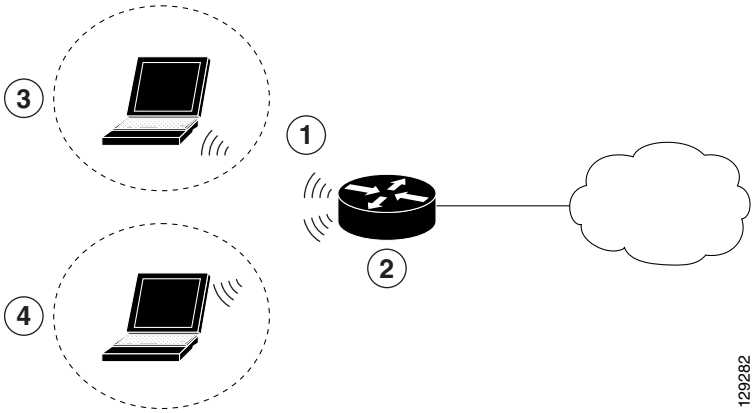
The Cisco Secure Router 520 Series routers support a secure, affordable, and easy-to-use wireless LAN solution that combines mobility and flexibility with the enterprise-class features required by networking professionals. With a management system based on Cisco IOS software, the Cisco routers act as access points, and are Wi-Fi certified, IEEE 802.11a/b/g-compliant wireless LAN transceivers.

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

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

Figure 9-1 shows a wireless network deployment.

Figure 9-1 Wireless Connection to the Cisco Router



1	Wireless LAN (with multiple networked devices)
2	Cisco Secure Router 520 Series router connected to the Internet
3	VLAN 1
4	VLAN 2

In the configuration example that follows, a remote user is accessing the Cisco Secure Router 520 Series router using a wireless connection. Each remote user has his own VLAN.

Configuration Tasks

Perform the following tasks to configure this network scenario:

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

A configuration example showing the results of these configuration tasks is provided in the "Configuration Example" section on page 9-6.

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

Configure the Root Radio Station

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

	Command	Purpose

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

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

	Command	Purpose

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

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

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

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

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

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

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

	Command	Purpose

Step 10	**power** [**client** | **local**] [**cck** [*number* | **maximum**] | **ofdm** [*number* | **maximum**]]
	
	Example:
	`Router(config-if)# power local cck 17`
	`Router(config-if)# power local ofdm 17`
	`Router(config-if)#`
		(Optional) Specifies the radio transmitter power level.
		
		See the *Cisco Access Router Wireless Configuration Guide* for available power level values.

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

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

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

Configure Bridging on VLANs

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

	Command or Action	Purpose

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

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

	Command or Action	Purpose

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

Step 4	**bridge-group** *parameter*
	
	Example:
	`Router(config-if)# bridge-group 1 spanning-disabled`
	`Router(config-if)#`
		Sets other bridge parameters for the bridging interface.

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

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

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

Configure Radio Station Subinterfaces

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

	Command	Purpose

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

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

	Command	Purpose

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

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

Step 5	**bridge-group** *number*
	
	Example:
	`Router(config-subif)# bridge-group 1`
	`Router(config-subif)#`
		Assigns a bridge group to the subinterface.
		
		Note When the bridge-group command is enabled, the following commands are automatically enabled, and cannot be disabled. If you disable these commands you may experience an interruption in wireless device communication.
		
		`bridge-group 1 subscriber-loop-control`
		
		`bridge-group 1 spanning-disabled`
		
		`bridge-group 1 block-unknown-source`

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

Repeat these steps to configure more subinterfaces, as needed.

Configuration Example

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

```
!
bridge irb
!
interface Dot11Radio0
 no ip address
 !
 broadcast-key vlan 1 change 45
 !
```

```
 !
 encryption vlan 1 mode ciphers tkip
 !
 ssid cisco
    vlan 1
    authentication open
    wpa-psk ascii 0 cisco123
    authentication key-management wpa
 !
 ssid ciscowep
    vlan 2
    authentication open
 !
 ssid ciscowpa
    vlan 3
    authentication open
 !
 speed basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0 24.0 36.0 48.0 54.0
 rts threshold 2312
 power local cck 50
 power local ofdm 30
 channel 2462
 station-role root
!
interface Dot11Radio0.1
 description Cisco Open
 encapsulation dot1Q 1 native
 no cdp enable
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
 bridge-group 1 block-unknown-source
 no bridge-group 1 source-learning
 no bridge-group 1 unicast-flooding
!
interface Dot11Radio0.2
 encapsulation dot1Q 2
 bridge-group 2
 bridge-group 2 subscriber-loop-control
 bridge-group 2 spanning-disabled
 bridge-group 2 block-unknown-source
 no bridge-group 2 source-learning
 no bridge-group 2 unicast-flooding
!
interface Dot11Radio0.3
 encapsulation dot1Q 3
 bridge-group 3
 bridge-group 3 subscriber-loop-control
 bridge-group 3 spanning-disabled
 bridge-group 3 block-unknown-source
 no bridge-group 3 source-learning
 no bridge-group 3 unicast-flooding
!
interface Vlan1
 no ip address
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface Vlan2
 no ip address
 bridge-group 2
 bridge-group 2 spanning-disabled
!
interface Vlan3
```

```
 no ip address
 bridge-group 3
 bridge-group 3 spanning-disabled
!
interface BVI1
 ip address 10.0.1.1 255.255.255.0
!
interface BVI2
 ip address 10.0.2.1 255.255.255.0
!
interface BVI3
 ip address 10.0.3.1 255.255.255.0
!
```

PART 3

Configuring Additional Features and Troubleshooting

CHAPTER 10

Additional Configuration Options

This part of the software configuration guide describes additional configuration options and troubleshooting tips for the Cisco Secure Router 520 Series routers.

The configuration options described in this part include:

- Chapter 11, “Configuring Security Features”
- Chapter 12, “Troubleshooting”

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

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

CHAPTER 11

Configuring Security Features

This chapter gives an overview of authentication, authorization, and accounting (AAA), the primary Cisco framework for implementing selected security features that can be configured on the Cisco Secure Router 520 Series routers.

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

This chapter contains the following sections:

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

Authentication, Authorization, and Accounting

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

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

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

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

Configuring AutoSecure

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

Configuring Access Lists

Access lists (ACLs) permit or deny network traffic over an interface based on source IP address, destination IP address, or protocol. Access lists are configured as standard or extended. A standard access list either permits or denies passage of packets from a designated source. An extended access list allows designation of both the destination and the source, and it allows designation of individual protocols to be permitted or denied passage. An access list is a series of commands with a common tag to bind them together. The tag is either a number or a name. Table 11-1 lists the commands used to configure access lists.

Table 11-1 Access List Configuration Commands

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

Access Groups

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

ip access-group {*access-list-number* | *access-list-name*}{**in** | **out**}

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

Guidelines for Creating Access Groups

Use the following guidelines when creating access groups.

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

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

Configuring a CBAC Firewall

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

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

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

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

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

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

Configuring Cisco IOS Firewall IDS

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

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

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

Configuring VPNs

A virtual private network (VPN) connection provides a secure connection between two networks over a public network such as the Internet. Cisco Secure Router 520 Series routers support site-to-site VPNs using IP security (IPsec) tunnels and generic routing encapsulation (GRE). Permanent VPN connections between two peers, or dynamic VPNs using EZVPN which create and tear down VPN connections as needed, can be configured. Chapter 6, "Configuring a VPN Using Easy VPN and an IPsec Tunnel," and Chapter 7, "Configuring VPNs Using an IPsec Tunnel and Generic Routing Encapsulation," show examples of how to configure your router with these features. For more information about IPsec and GRE configuration, see the "Configuring IPsec Network Security" chapter of the *Cisco IOS Release 12.3 Security Configuration Guide*.

For information about additional VPN configurations supported by Cisco Secure Router 520 Series routers, see the *EZVPN Server* feature document. Cisco Secure Router 520 Series routers can be configured to act as EZVPN servers, letting authorized EZVPN clients establish dynamic VPN tunnels to the connected network.

CHAPTER 12

Troubleshooting

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

Getting Started

Before troubleshooting a software problem, you must connect a terminal or PC to the router using the light-blue console port. With a connected terminal or PC, you can view status messages from the router and enter commands to troubleshoot a problem.

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

Before Contacting Cisco or Your Reseller

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

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

ADSL Troubleshooting

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

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

ATM Troubleshooting Commands

Use the following commands to troubleshoot your ATM interface.

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

ping atm interface Command

Use the **ping atm interface** command to determine whether a particular PVC is in use. The PVC does not need to be configured on the router to use this command. Example 12-1 shows the use of this command to determine whether PVC 8/35 is in use.

Example 12-1 Determining If a PVC Is in Use

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

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

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

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

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

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

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

show interface Command

Use the **show interface** command to display the status of all physical ports (Ethernet and ATM) and logical interfaces on the router. Table 12-1 describes messages in the command output.

Example 12-2 Viewing Status of Selected Interfaces

```
Router# show interface atm 0
ATM0 is up, line protocol is up
  Hardware is PQUICC_SAR (with Alcatel ADSL Module)
  Internet address is 14.0.0.16/8
  MTU 1500 bytes, sub MTU 1500, BW 640 Kbit, DLY 80 usec,
     reliability 40/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s):AAL5, PVC mode
  10 maximum active VCs, 1 current VCCs
  VC idle disconnect time:300 seconds
  Last input 01:16:31, output 01:16:31, output hang never
  Last clearing of "show interface" counters never
  Input queue:0/75/0 (size/max/drops); Total output drops:0
  Queueing strategy:Per VC Queuing
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     512 packets input, 59780 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 1024 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     426 packets output, 46282 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out

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

Router# show interface dialer 1
Dialer 1 is up, line protocol is up
    Hardware is Dialer interface
    Internet address is 1.1.1.1/24
    MTU 1500 bytes, BW 100000 Kbit, DLY 100000 usec, reliability
        255/255. txload 1/255, rxload 1/255
    Encapsulation PPP, loopback not set
    Keepalive set (10 sec)
DTR is pulsed for 5 seconds on reset
LCP Closed
```

Table 12-1 describes possible command output for the **show interface** command.

Table 12-1 show interface Command Output Description

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

show atm interface Command

To display ATM-specific information about an ATM interface, use the **show atm interface atm 0 command from** privileged EXEC mode, as shown in Example 12-3.

Example 12-3 Viewing Information About an ATM Interface

```
Router# show atm interface atm 0
Interface ATM0:
AAL enabled: AAL5 , Maximum VCs:11, Current VCCs:0

Maximum Transmit Channels:0
Max. Datagram Size:1528
PLIM Type:INVALID - 640Kbps, Framing is INVALID,
DS3 lbo:short, TX clocking:LINE
0 input, 0 output, 0 IN fast, 0 OUT fast
Avail bw = 640
Config. is ACTIVE
```

Table 12-2 describes some of the fields shown in the command output.

Table 12-2 show atm interface Command Output Description

Field	Description
ATM interface	Interface number. Always 0 for the Cisco Secure Router 520 Series router.
AAL enabled	Type of AAL enabled. The Cisco Secure Router 520 Series routers support AAL5.
Maximum VCs	Maximum number of virtual connections this interface supports.
Current VCCs	Number of active virtual channel connections (VCCs).
Maximum Transmit Channels	Maximum number of transmit channels.
Max Datagram Size	Configured maximum number of bytes in the largest datagram.
PLIM Type	Physical layer interface module (PLIM) type.

debug atm Commands

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

Guidelines for Using Debug Commands

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

- All debug commands are entered in privileged EXEC mode.
- To view debugging messages on a console, enter the **logging console debugging** command.
- Most **debug** commands take no arguments.

- To disable debugging, enter the **undebug all** command.
- To use **debug** commands during a Telnet session on your router, enter the **terminal monitor** command.

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

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

debug atm errors Command

Use the **debug atm errors** command to display ATM errors. The **no** form of this command disables debugging output. Example 12-4 shows a sample output.

Example 12-4 Viewing ATM Errors

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

debug atm events Command

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

If the interface is successfully communicating with the Digital Subscriber Line Access Multiplexer (DSLAM) at the telephone company, the modem state is 0x10. If the interface is not communicating with the DSLAM, the modem state is 0x8. Example 12-5 shows an ADSL line that is up and training successfully. Example 12-6 shows an ADSL line that is not communicating correctly. Note that the modem state does not transition to 0x10.

Example 12-5 Viewing ATM Interface Processor Events—Success

```
Router# debug atm events
Router#
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Sent command 0x5
00:02:57: DSL: Received response: 0x26
00:02:57: DSL: Unexpected response 0x26
00:02:57: DSL: Send ADSL_OPEN command.
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Using subfunction 0xA
00:02:57: DSL: Sent command 0x5
```

```
00:03:00: DSL: 1: Modem state = 0x8
00:03:02: DSL: 2: Modem state = 0x10
00:03:05: DSL: 3: Modem state = 0x10
00:03:07: DSL: 4: Modem state = 0x10
00:03:09: DSL: Received response: 0x24
00:03:09: DSL: Showtime!
00:03:09: DSL: Sent command 0x11
00:03:09: DSL: Received response: 0x61
00:03:09: DSL: Read firmware revision 0x1A04
00:03:09: DSL: Sent command 0x31
00:03:09: DSL: Received response: 0x12
00:03:09: DSL: operation mode 0x0001
00:03:09: DSL: SM: [DMTDSL_DO_OPEN -> DMTDSL_SHOWTIME]
```

Example 12-6 Viewing ATM Interface Processor Events—Failure

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

debug atm packet Command

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

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

The command syntax is:

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

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

where the keywords are defined as follows:

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

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

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

Example 12-7 shows sample output for the **debug atm packet** command.

Example 12-7 Viewing ATM Packet Processing

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

Table 12-3 describes some of the fields shown in the **debug atm packet** command output.

Table 12-3 debug atm packet Command Output Description

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

Software Upgrade Methods

Several methods are available for upgrading software on the Cisco Secure Router 520 Series routers, including:

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

Recovering a Lost Password

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

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

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

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

Change the Configuration Register

To change a configuration register, follow these steps:

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

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

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

```
Router# show version
Cisco IOS Software, SR520 Software (SR520-ADVIPSERVICESK9-M), Experimental Version
12.4(20070608:212108) [rhsu2k-p121 190]
Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Fri 08-Jun-07 15:16 by rhsu2k

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

Router uptime is 29 minutes
System returned to ROM by power-on
Running default software

This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.
A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

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

```
Cisco SR520W-ADSL (MPC8272) processor (revision 0x100) with 118784K/12288K bytes of
memory.

Processor board ID FOC09171CB7
MPC8272 CPU Rev: Part Number 0xC, Mask Number 0x10
4 FastEthernet interfaces
1 ATM interface
1 802.11 Radio
128K bytes of non-volatile configuration memory.
20480K bytes of processor board System flash (Intel Strataflash)

Configuration register is 0x0
```

Step 4 Record the setting of the configuration register.

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

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

Reset the Router

To reset the router, follow these steps:

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

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

Step 2 Press **break**. The terminal displays the following prompt:

```
rommon 2>
```

Step 3 Enter **confreg 0x2142** to reset the configuration register:

```
rommon 2> confreg 0x2142
```

Step 4 Initialize the router by entering the **reset** command:

```
rommon 2> reset
```

The router cycles its power, and the configuration register is set to 0x2142. The router uses the boot ROM system image, indicated by the system configuration dialog:

```
--- System Configuration Dialog ---
```

Step 5 Enter **no** in response to the prompts until the following message is displayed:

```
Press RETURN to get started!
```

Step 6 Press **Return**. The following prompt appears:

```
Router>
```

Step 7 Enter the **enable** command to enter enable mode. Configuration changes can be made only in enable mode:

```
Router> enable
```

The prompt changes to the privileged EXEC prompt:

```
Router#
```

Step 8 Enter the **show startup-config** command to display an enable password in the configuration file:

```
Router# show startup-config
```

If you are recovering an enable password, do not perform the steps in the following "Reset the Password and Save Your Changes" section. Instead, complete the password recovery process by performing the steps in the "Reset the Configuration Register Value" section.

If you are recovering an enable secret password, it is not displayed in the **show startup-config** command output. Complete the password recovery process by performing the steps in the following "Reset the Password and Save Your Changes" section.

Reset the Password and Save Your Changes

To reset your password and save the changes, follow these steps:

Step 1 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
```

Step 2 Enter the **enable secret** command to reset the enable secret password in the router:

```
Router(config)# enable secret password
```

Step 3 Enter **exit** to exit global configuration mode:

```
Router(config)# exit
```

Step 4 Save your configuration changes:

```
Router# copy running-config startup-config
```

Reset the Configuration Register Value

To reset the configuration register value after you have recovered or reconfigured a password, follow these steps:

Step 1 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
```

Step 2 Enter the **configure register** command and the original configuration register value that you recorded.

```
Router(config)# config-reg value
```

Step 3 Enter **exit** to exit configuration mode:

```
Router(config)# exit
```

Note To return to the configuration being used before you recovered the lost enable password, do not save the configuration changes before rebooting the router.

Step 4 Reboot the router, and enter the recovered password.

PART 4

Reference Information

APPENDIX A

Cisco IOS Software Basic Skills

Understanding how to use Cisco IOS software can save you time when you are configuring your router. If you need a refresher, take a few minutes to read this appendix.

This appendix contains the following sections:

If you are already familiar with Cisco IOS software, go to one of the following chapters:

- Chapter 1, “Basic Router Configuration”
- Chapter 2, “Sample Network Deployments”
- One of the configuration topic chapters described in Chapter 10, “Additional Configuration Options.”

Configuring the Router from a PC

You can configure your router from a PC connected through the console port using *terminal emulation* software. The PC uses this software to send commands to your router. Table A-1 lists some common types of this software, which are based on the type of PC you are using.

Table A-1 Terminal Emulation Software

PC Operating System	Software
Windows 95, Windows 98, Windows 2000, Windows NT, Windows XP	HyperTerm (included with Windows software), ProComm Plus

Table A-1 Terminal Emulation Software

PC Operating System	Software
Windows 3.1	Terminal (included with Windows software)
Macintosh	ProComm, VersaTerm (supplied separately)

You can use the terminal emulation software to change settings for the type of device that is connected to the PC, in this case a router. Configure the software to the following standard VT-100 emulation settings so that your PC can communicate with your router:

- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- No flow control

These settings should match the default settings of your router. To change the router baud, data bits, parity, or stop bits settings, you must reconfigure parameters in the ROM monitor. For more information, see Appendix C, "ROM Monitor." To change the router flow control setting, use the **flowcontrol** line configuration command.

For information on how to enter global configuration mode so that you can configure your router, see the "Entering Global Configuration Mode" section later in this chapter.

Understanding Command Modes

This section describes the Cisco IOS command mode structure. Each command mode supports specific Cisco IOS commands. For example, you can use the **interface** *type number* command only from global configuration mode.

The following Cisco IOS command modes are hierarchical. When you begin a router session, you are in user EXEC mode.

- User EXEC
- Privileged EXEC
- Global configuration

Table A-2 lists the command modes that are used in this guide, how to access each mode, the prompt you see in that mode, and how to exit to a mode or enter the next mode. Because each mode configures different router elements, you might need to enter and exit modes frequently. You can see a list of available commands for a particular mode by entering a question mark (?) at the prompt. For a description of each command, including syntax, see the Cisco IOS Release 12.3 documentation set.

Table A-2 Command Modes Summary

Mode	Access Method	Prompt	Exit and Entrance Method	About This Mode
User EXEC	Begin a session with your router.	`Router>`	To exit a router session, enter the **logout** command.	Use this mode for these tasks: • Change terminal settings. • Perform basic tests. • Display system information.
Privileged EXEC	Enter the **enable** command from user EXEC mode.	`Router#`	• To exit to user EXEC mode, enter the **disable** command. • To enter global configuration mode, enter the **configure** command.	Use this mode for these tasks: • Configure your router operating parameters. • Perform the verification steps shown in this guide. To prevent unauthorized changes to your router configuration, access to this mode should be protected with a password as described in "Enable Secret Passwords and Enable Passwords" later in this chapter.
Global configuration	Enter the **configure** command from privileged EXEC mode.	`Router (config)#`	• To exit to privileged EXEC mode, enter the **exit** or **end** command, or press **Ctrl-Z**. • To enter interface configuration mode, enter the **interface** command.	Use this mode to configure parameters that apply to your router as a whole. Also, you can access the following modes, which are described later in this table: • Interface configuration • Router configuration • Line configuration
Interface configuration	Enter the **interface** command (with a specific interface, such as **interface atm 0**) from global configuration mode.	`Router (config-if)#`	• To exit to global configuration mode, enter the **exit** command. • To exit to privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**. • To enter subinterface configuration mode, specify a subinterface with the **interface** command.	Use this mode to configure parameters for the router Ethernet and serial interfaces or subinterfaces.

Table A-2 Command Modes Summary (continued)

Mode	Access Method	Prompt	Exit and Entrance Method	About This Mode
Router configuration	Enter one of the **router** commands followed by the appropriate keyword, for example **router rip**, from global configuration mode.	`Router (config-router)#`	• To exit to global configuration mode, enter the **exit** command. • To exit to privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**.	Use this mode to configure an IP routing protocol.
Line configuration	Enter the **line** command with the desired line number 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 at that command mode, enter a question mark:

```
Router> ?
access-enable  Create a temporary access-list entry
access-profile Apply user-profile to interface
clear          Reset functions
...
```

To complete a command, enter a few known characters followed by a question mark (with no space):

```
Router> s?
* s=show set show slip systat
```

For a list of command variables, enter the command followed by a space and a question mark:

```
Router> show ?
...
clock      Display the system clock
dialer     Dialer parameters and statistics
exception  exception information
...
```

To redisplay a command you previously entered, press the **Up Arrow** key. You can continue to press the **Up Arrow** key for more commands.

Enable Secret Passwords and Enable Passwords

By default, the router ships without password protection. Because many privileged EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use.

You can use two commands to do this:

- **enable secret** *password*—A very secure, encrypted password
- **enable** *password*—A less secure, unencrypted local password

Both the **enable** and **enable secret** passwords control access to various privilege levels (0 to 15). The **enable** password is intended for local use and is thus unencrypted. The **enable secret** password is intended for network use; that is, in environments where the password crosses the network or is stored on a TFTP server. You must enter an **enable secret** or **enable** password with a privilege level of 1 to gain access to privileged EXEC mode commands.

For maximum security, the passwords should be different. If you enter the same password for both during the setup process, your router accepts the passwords, but warns you that they should be different.

An **enable secret** password can contain from 1 to 25 uppercase and lowercase alphanumeric characters. An **enable** password can contain any number of uppercase and lowercase alphanumeric characters. In both cases, a number cannot be the first character. Spaces are also valid password characters; for example, *two words* is a valid password. Leading spaces are ignored; trailing spaces are recognized.

Entering Global Configuration Mode

To make any configuration changes to your router, you must be in global configuration mode. This section describes how to enter global configuration mode while using a terminal or PC that is connected to your router console port.

To enter global configuration mode, follow these steps:

Step 1 After your router boots up, enter the **enable** or **enable secret** command:

```
Router> enable
```

Step 2 If you have configured your router with an enable password, enter it when you are prompted.

The enable password does not appear on the screen when you enter it. This example shows how to enter privileged EXEC mode:

```
Password: enable_password
Router#
```

Privileged EXEC mode is indicated by the # in the prompt. You can now make changes to your router configuration.

Step 3 Enter the **configure terminal** command to enter global configuration mode:

```
Router# configure terminal
Router(config)#
```

You can now make changes to your router configuration.

Using Commands

This section provides some tips about entering Cisco IOS commands at the command-line interface (CLI).

Abbreviating Commands

You only have to enter enough characters for the router to recognize the command as unique. This example shows how to enter the **show version** command:

```
Router # sh v
```

Undoing Commands

If you want to disable a feature or undo a command you entered, you can enter the keyword **no** before most commands; for example, **no ip routing**.

Command-Line Error Messages

Table A-3 lists some error messages that you might encounter while using the CLI to configure your router.

Table A-3 Common CLI Error Messages

Error Message	Meaning	How to Get Help
`% Ambiguous command: "show con”`	You did not enter enough characters for your router to recognize the command.	Reenter the command, followed by a question mark (**?**) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Incomplete command.`	You did not enter all of the keywords or values required by this command.	Reenter the command, followed by a question mark (**?**) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Invalid input detected at '^' marker.`	You entered the command incorrectly. The error occurred where the caret mark (^) appears.	Enter a question mark (**?**) to display all of the commands that are available in this particular command mode.

Saving Configuration Changes

You need to enter the **copy running-config startup-config** command to save your configuration changes to nonvolatile RAM (NVRAM) so that they are not lost if there is a system reload or power outage. This example shows how to use this command to save your changes:

```
Router# copy running-config startup-config
Destination filename [startup-config]?
```

Press **Return** to accept the default destination filename *startup-config*, or enter your desired destination filename and press **Return**.

It might take a minute or two to save the configuration to NVRAM. After the configuration has been saved, the following message appears:

```
Building configuration...
Router#
```

Summary

Now that you have reviewed some Cisco IOS software basics, you can begin to configure your router. Remember:

- You can use the question mark (**?**) and arrow keys to help you enter commands.
- Each command mode restricts you to a set of commands. If you are having difficulty entering a command, check the prompt, and then enter the question mark (**?**) for a list of available commands. You might be in the wrong command mode or using the wrong syntax.
- If you want to disable a feature, enter the keyword **no** before the command; for example, **no ip routing**.
- Save your configuration changes to NVRAM so that they are not lost if there is a system reload or power outage.

Where to Go Next

To configure your router, go to Chapter 1, "Basic Router Configuration," and Chapter 2, "Sample Network Deployments."

APPENDIX B

Concepts

This appendix contains conceptual information that may be useful to Internet service providers or network administrators when they configure Cisco routers. To review some typical network scenarios, see Chapter 2, "Sample Network Deployments." For information on additional details or configuration topics, see Chapter 10, "Additional Configuration Options."

The following topics are included in this appendix:

- ADSL
- Network Protocols
- Routing Protocol Options
- PPP Authentication Protocols
- TACACS+
- Network Interfaces
- NAT
- Easy IP (Phase 1)
- Easy IP (Phase 2)
- QoS
- Access Lists

ADSL

ADSL is a technology that allows both data and voice to be transmitted over the same line. It is a packet-based network technology that allows high-speed transmission over twisted-pair copper wire on the local loop ("last mile") between a network service provider (NSP) central office and the customer site, or on local loops created within either a building or a campus.

The benefit of ADSL over a serial or dialup line is that it is always on and always connected, increasing bandwidth and lowering the costs compared with a dialup or leased line. ADSL technology is asymmetric in that it allows more bandwidth from an NSP central office to the customer site than from the customer site to the central office. This asymmetry, combined with always-on access (which eliminates call setup), makes ADSL ideal for Internet and intranet surfing, video on demand, and remote LAN access.

Network Protocols

Network protocols enable the network to pass data from its source to a specific destination over LAN or WAN links. Routing address tables are included in the network protocols to provide the best path for moving the data through the network.

IP

The best-known Transmission Control Protocol/Internet Protocol (TCP/IP) at the internetwork layer is IP, which provides the basic packet delivery service for all TCP/IP networks. In addition to the physical node addresses, the IP protocol implements a system of logical host addresses called IP addresses. The IP addresses are used by the internetwork and higher layers to identify devices and to perform internetwork routing. The Address Resolution Protocol (ARP) enables IP to identify the physical address that matches a given IP address.

IP is used by all protocols in the layers above and below it to deliver data, which means that all TCP/IP data flows through IP when it is sent and received regardless of its final destination.

IP is a connectionless protocol, which means that IP does not exchange control information (called a *handshake*) to establish an end-to-end connection before transmitting data. In contrast, a connection-oriented protocol exchanges control information with the remote computer to verify that it is ready to receive data before sending it. When the handshaking is successful, the computers have established a connection. IP relies on protocols in other layers to establish the connection if connection-oriented services are required.

Internet Packet Exchange (IPX) exchanges routing information using Routing Information Protocol (RIP), a dynamic distance-vector routing protocol. RIP is described in more detail in the following subsections.

Routing Protocol Options

Routing protocols include Routing Information Protocol (RIP).

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.

PPP Authentication Protocols

The Point-to-Point Protocol (PPP) encapsulates network layer protocol information over point-to-point links.

PPP originally emerged as an encapsulation protocol for transporting IP traffic over point-to-point links. PPP also established a standard for the assignment and management of IP addresses, asynchronous (start/stop) and bit-oriented synchronous encapsulation, network protocol multiplexing, link configuration, link quality testing, error detection, and option negotiation for such capabilities as network-layer address negotiation and data-compression negotiation. PPP supports these functions by providing an extensible Link Control Protocol (LCP) and a family of Network Control Protocols (NCPs) to negotiate optional configuration parameters and facilities.

The current implementation of PPP supports two security authentication protocols to authenticate a PPP session:

- Password Authentication Protocol (PAP)
- Challenge Handshake Authentication Protocol (CHAP)

PPP with PAP or CHAP authentication is often used to inform the central site which remote routers are connected to it.

PAP

PAP uses a two-way handshake to verify the passwords between routers. To illustrate how PAP works, imagine a network topology in which a remote office Cisco router is connected to a corporate office Cisco router. After the PPP link is established, the remote office router repeatedly sends a configured username and password until the corporate office router accepts the authentication.

PAP has the following characteristics:

- The password portion of the authentication is sent across the link in clear text (not scrambled or encrypted).
- PAP provides no protection from playback or repeated trial-and-error attacks.
- The remote office router controls the frequency and timing of the authentication attempts.

CHAP

CHAP uses a three-way handshake to verify passwords. To illustrate how CHAP works, imagine a network topology in which a remote office Cisco router is connected to a corporate office Cisco router.

After the PPP link is established, the corporate office router sends a challenge message to the remote office router. The remote office router responds with a variable value. The corporate office router checks the response against its own calculation of the value. If the values match, the corporate office router accepts the authentication. The authentication process can be repeated any time after the link is established.

CHAP has the following characteristics:

- The authentication process uses a variable challenge value rather than a password.
- CHAP protects against playback attack through the use of the variable challenge value, which is unique and unpredictable. Repeated challenges limit the time of exposure to any single attack.
- The corporate office router controls the frequency and timing of the authentication attempts.

Note We recommend using CHAP because it is the more secure of the two protocols.

TACACS+

Cisco Secure Router 520 Series routers support the Terminal Access Controller Access Control System Plus (TACACS+) protocol through Telnet. TACACS+ is a Cisco proprietary authentication protocol that provides remote access authentication and related network security services, such as event logging. User passwords are administered in a central database rather than in individual routers. TACACS+ also provides support for separate modular authentication, authorization, and accounting (AAA) facilities that are configured at individual routers.

Network Interfaces

This section describes the network interface protocols that Cisco Secure Router 520 Series routers support. The following network interface protocols are supported:

- Ethernet
- ATM for DSL

Ethernet

Ethernet is a baseband LAN protocol that transports data and voice packets to the WAN interface using carrier sense multiple access collision detect (CSMA/CD). The term is now often used to refer to all CSMA/CD LANs. Ethernet was designed to serve in networks with sporadic, occasionally heavy traffic requirements, and the IEEE 802.3 specification was developed in 1980 based on the original Ethernet technology.

Under the Ethernet CSMA/CD media-access process, any host on a CSMA/CD LAN can access the network at any time. Before sending data, CSMA/CD hosts listen for traffic on the network. A host wanting to send data waits until it detects no traffic before it transmits. Ethernet allows any host on the network to transmit whenever the network is quiet. A collision occurs when two hosts listen for traffic, hear none, and then transmit simultaneously. In this situation, both transmissions are damaged, and the hosts must retransmit at some later time. Algorithms determine when the colliding hosts should retransmit.

ATM for DSL

Asynchronous Transfer Mode (ATM) is a high-speed multiplexing and switching protocol that supports multiple traffic types, including voice, data, video, and imaging.

ATM is composed of fixed-length cells that switch and multiplex all information for the network. An ATM connection is simply used to transfer bits of information to a destination router or host. The ATM network is considered a LAN with high bandwidth availability. Unlike a LAN, which is connectionless, ATM requires certain features to provide a LAN environment to the users.

Each ATM node must establish a separate connection to every node in the ATM network that it needs to communicate with. All such connections are established through a permanent virtual circuit (PVC).

PVC

A PVC is a connection between remote hosts and routers. A PVC is established for each ATM end node with which the router communicates. The characteristics of the PVC that are established when it is created are set by the ATM adaptation layer (AAL) and the encapsulation type. An AAL defines the conversion of user information into cells. An AAL segments upper-layer information into cells at the transmitter and reassembles the cells at the receiver.

Cisco routers support the AAL5 format, which provides a streamlined data transport service that functions with less overhead and affords better error detection and correction capabilities than AAL3/4. AAL5 is typically associated with variable bit rate (VBR) traffic and unspecified bit rate (UBR) traffic.

ATM encapsulation is the wrapping of data in a particular protocol header. The type of router that you are connecting to determines the type of ATM PVC encapsulation.

The routers support the following encapsulation types for ATM PVCs:

- LLC/SNAP (RFC 1483)
- VC-MUX (RFC 1483)
- PPP (RFC 2364)

Each PVC is considered a complete and separate link to a destination node. Users can encapsulate data as needed across the connection. The ATM network disregards the contents of the data. The only requirement is that data be sent to the ATM subsystem of the router in a manner that follows the specific AAL format.

Dialer Interface

A dialer interface assigns PPP features (such as authentication and IP address assignment method) to a PVC. Dialer interfaces are used when configuring PPP over ATM.

Dialer interfaces can be configured independently of any physical interface and applied dynamically as needed.

NAT

Network Address Translation (NAT) provides a mechanism for a privately addressed network to access registered networks, such as the Internet, without requiring a registered subnet address. This mechanism eliminates the need for host renumbering and allows the same IP address range to be used in multiple intranets.

NAT is configured on the router at the border of an *inside network* (a network that uses nonregistered IP addresses) and an *outside network* (a network that uses a globally unique IP address; in this case, the Internet). NAT translates the inside local addresses (the nonregistered IP addresses assigned to hosts on the inside network) into globally unique IP addresses before sending packets to the outside network.

With NAT, the inside network continues to use its existing private or obsolete addresses. These addresses are converted into legal addresses before packets are forwarded onto the outside network. The translation function is compatible with standard routing; the feature is required only on the router connecting the inside network to the outside domain.

Translations can be static or dynamic. A static address translation establishes a one-to-one mapping between the inside network and the outside domain. Dynamic address translations are defined by describing the local addresses to be translated and the pool of addresses from which to allocate outside addresses. Allocation occurs in numeric order, and multiple pools of contiguous address blocks can be defined.

NAT eliminates the need to readdress all hosts that require external access, saving time and money. It also conserves addresses through application port-level multiplexing. With NAT, internal hosts can share a single registered IP address for all external communications. In this type of configuration, relatively few external addresses are required to support many internal hosts, thus conserving IP addresses.

Because the addressing scheme on the inside network may conflict with registered addresses already assigned within the Internet, NAT can support a separate address pool for overlapping networks and translate as appropriate.

Easy IP (Phase 1)

The Easy IP (Phase 1) feature combines Network Address Translation (NAT) and PPP/Internet Protocol Control Protocol (IPCP). This feature enables a Cisco router to automatically negotiate its own registered WAN interface IP address from a central server and to enable all remote hosts to access the Internet using this single registered IP address. Because Easy IP (Phase 1) uses existing port-level multiplexed NAT functionality within Cisco IOS software, IP addresses on the remote LAN are invisible to the Internet.

The Easy IP (Phase 1) feature combines NAT and PPP/IPCP. With NAT, the router translates the nonregistered IP addresses used by the LAN devices into the globally unique IP address used by the dialer interface. The ability of multiple LAN devices to use the same globally unique IP address is known as *overloading*. NAT is configured on the router at the border of an inside network (a network that uses nonregistered IP addresses) and an outside network (a network that uses a globally unique IP address; in this case, the Internet).

With PPP/IPCP, Cisco routers automatically negotiate a globally unique (registered) IP address for the dialer interface from the ISP router.

Easy IP (Phase 2)

The Easy IP (Phase 2) feature combines Dynamic Host Configuration Protocol (DHCP) server and relay. DHCP is a client-server protocol that enables devices on an IP network (the DHCP clients) to request configuration information from a DHCP server. DHCP allocates network addresses from a central pool on an as-needed basis. DHCP is useful for assigning IP addresses to hosts connected to the network temporarily or for sharing a limited pool of IP addresses among a group of hosts that do not need permanent IP addresses.

DHCP frees you from having to assign an IP address to each client manually.

DHCP configures the router to forward UDP broadcasts, including IP address requests, from DHCP clients. DHCP allows for increased automation and fewer network administration problems by:

- Eliminating the need for the manual configuration of individual computers, printers, and shared file systems
- Preventing the simultaneous use of the same IP address by two clients
- Allowing configuration from a central site

QoS

This section describes Quality of Service (QoS) parameters, including the following:

- IP Precedence
- PPP Fragmentation and Interleaving
- CBWFQ
- RSVP
- Low Latency Queuing

QoS refers to the capability of a network to provide better service to selected network traffic over various technologies, including ATM, Ethernet and IEEE 802.1 networks, and IP-routed networks that may use any or all of these underlying technologies. Primary goals of QoS include dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics. QoS technologies provide the elemental building blocks for future business applications in campus, WAN, and service provider networks.

QoS must be configured throughout your network, not just on your router running VoIP, to improve voice network performance. Not all QoS techniques are appropriate for all network routers. Edge routers and backbone routers in your network do not necessarily perform the same operations; the QoS tasks they perform might differ as well. To configure your IP network for real-time voice traffic, you need to consider the functions of both edge and backbone routers in your network.

QoS software enables complex networks to control and predictably service a variety of networked applications and traffic types. Almost any network can take advantage of QoS for optimum efficiency, whether it is a small corporate network, an Internet service provider, or an enterprise network.

IP Precedence

You can partition traffic in up to six classes of service using IP Precedence (two others are reserved for internal network use). The queuing technologies throughout the network can then use this signal to expedite handling.

Features such as policy-based routing and committed access rate (CAR) can be used to set precedence based on extended access-list classification. This allows considerable flexibility for precedence assignment, including assignment by application or user, by destination and source subnet, and so on. Typically this functionality is deployed as close to the edge of the network (or administrative domain) as possible, so that each subsequent network element can provide service based on the determined policy.

IP Precedence can also be set in the host or network client with the signaling used optionally. IP Precedence enables service classes to be established using existing network queuing mechanisms (such as class-based weighted fair queuing [CBWFQ]) with no changes to existing applications or complicated network requirements.

PPP Fragmentation and Interleaving

With multiclass multilink PPP interleaving, large packets can be multilink-encapsulated and fragmented into smaller packets to satisfy the delay requirements of real-time voice traffic; small real-time packets, which are not multilink encapsulated, are transmitted between fragments of the large packets. The interleaving feature also provides a special transmit queue for the smaller, delay-sensitive packets, enabling them to be transmitted earlier than other flows. Interleaving provides the delay bounds for delay-sensitive voice packets on a slow link that is used for other best-effort traffic.

In general, multilink PPP with interleaving is used in conjunction with CBWFQ and RSVP or IP Precedence to ensure voice packet delivery. Use multilink PPP with interleaving and CBWFQ to define how data is managed; use Resource Reservation Protocol (RSVP) or IP Precedence to give priority to voice packets.

CBWFQ

In general, class-based weighted fair queuing (CBWFQ) is used in conjunction with multilink PPP and interleaving and RSVP or IP Precedence to ensure voice packet delivery. CBWFQ is used with multilink PPP to define how data is managed; RSVP or IP Precedence is used to give priority to voice packets.

There are two levels of 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

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 in this appendix. After the router reboots, it is in ROM monitor mode. The number in the prompt increments with each new line.

Timesaver Break (system interrupt) is always enabled for 60 seconds after the router reboots, regardless of whether it is set to on or off in the configuration register. During this 60-second window, you can break to the ROM monitor prompt by pressing the Break key.

ROM Monitor Commands

Enter **?** or **help** at the ROM monitor prompt to display a list of available commands and options, as follows:

```
rommon 1 > ?
alias             set and display aliases command
boot              boot up an external process
break             set/show/clear the breakpoint
confreg           configuration register utility
cont              continue executing a downloaded image
context           display the context of a loaded image
cookie            display contents of cookie PROM in hex
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> c870-advsecurityk9-mz`
	`9064448 bytes available (10289152 bytes used)`

boot commands	For more information about the ROM monitor boot commands, see the *Cisco IOS Configuration Fundamentals and Network Management Guide*.
b	Boots the first image in flash memory.
b flash: [*filename*]	Attempts to boot the image directly from the first partition of flash memory. If you do not enter a filename, this command will boot this first image in flash memory.

Disaster Recovery with TFTP Download

The standard way to load new software on your router is to use the **copy tftp flash** privileged EXEC command from the Cisco IOS software command-line interface (CLI). However, if the router is unable to boot Cisco IOS software, you can load new software while in ROM monitor mode.

This section describes how to load a Cisco IOS software image from a remote TFTP server to the router flash memory. Use the **tftpdnld** command only for disaster recovery, because it erases all existing data in flash memory before downloading a new software image to the router.

TFTP Download Command Variables

This section describes the system variables that can be set in ROM monitor mode and that are used during the TFTP download process. There are both required variables and optional variables.

Note The commands described in this section are case sensitive and must be entered exactly as shown.

Required Variables

These variables must be set with these commands before you use the **tftpdnld** command:

Variable	Command
IP address of the router.	**IP_ADDRESS=** *ip_address*
Subnet mask of the router.	**IP_SUBNET_MASK=** *ip_address*
IP address of the default gateway of the router.	**DEFAULT_GATEWAY=** *ip_address*
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 2,400 seconds (40 minutes).	**TFTP_TIMEOUT=** *time*
Whether or not the router performs a checksum test on the downloaded image: 1—Checksum test is performed. 0—No checksum test is performed.	**TFTP_CHECKSUM=***setting*

Using the TFTP Download Command

Perform these steps in ROM monitor mode to download a file through TFTP:

Step 1 Use the appropriate commands to enter all the required variables and any optional variables described in preceding sections.

Step 2 Enter the **tftpdnld** command as follows:

```
rommon 1 > tftpdnld
```

You will see output similar to the following:

```
IP_ADDRESS: 10.3.6.7
IP_SUBNET_MASK: 255.255.0.0
DEFAULT_GATEWAY: 10.3.0.1
TFTP_SERVER: 192.168.254.254
TFTP_FILE: sr520-adipservicessk9-mz
Do you wish to continue? y/n:  [n]:
```

Step 3 If you are sure that you want to continue, enter **y** in response to the question in the output:

```
Do you wish to continue? y/n:  [n]:y
```

The router begins to download the new file.

If you mistakenly entered yes, you can enter **Ctrl-C** or **Break** to stop the transfer before the flash memory is erased.

Configuration Register

The virtual configuration register is in nonvolatile RAM (NVRAM) and has the same functionality as other Cisco routers. You can view or modify the virtual configuration register from either the ROM monitor or the operating system software. Within the ROM monitor, you can change the configuration register by entering the register value in hexadecimal format, or by allowing the ROM monitor to prompt you for the setting of each bit.

Changing the Configuration Register Manually

To change the virtual configuration register from the ROM monitor manually, enter the **confreg** command followed by the new value of the register in hexadecimal format, as shown in the following example:

```
rommon 1 > confreg 0x2101


You must reset or power cycle for new config to take effect
rommon 2 >
```

The value is always interpreted as hexadecimal. The new virtual configuration register value is written into NVRAM but does not take effect until you reset or reboot the router.

Changing the Configuration Register Using Prompts

Entering the **confreg** command without an argument displays the contents of the virtual configuration register and a prompt to alter the contents by describing the meaning of each bit.

In either case, the new virtual configuration register value is written into NVRAM but does not take effect until you reset or reboot the router.

The following display shows an example of entering the **confreg** command:

```
rommon 7> confreg

     Configuration Summary
enabled are:
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:  y
enable  "diagnostic mode"? y/n  [n]:  y
enable "use net in IP bcast address"? y/n  [n]:
enable "load rom after netboot fails"? y/n  [n]:
enable "use all zero broadcast"? y/n  [n]:
enable "break/abort has effect"? y/n  [n]:
enable "ignore system config info"? y/n  [n]:
change console baud rate? y/n  [n]:  y
enter rate: 0 = 9600, 1 = 4800, 2 = 1200, 3 = 2400  [0]:  0
change the boot characteristics? y/n  [n]:  y
enter to boot:
 0 = ROM Monitor
 1 = the boot helper image
 2-15 = boot system
    [0]:  0

Configuration Summary
enabled are:
diagnostic mode
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:


You must reset or power cycle for new config to take effect
```

Console Download

You can use console download, a ROM monitor function, to download either a software image or a configuration file over the router console port. After download, the file is either saved to the 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. In order for the router to recognize it, the name of the configuration file must be *router_confg*.

Follow these steps to run Xmodem:

Step 1 Move the image file to the local drive where Xmodem will execute.

Step 2 Enter the **xmodem** command.

Error Reporting

Because the ROM monitor console download uses the console to perform the data transfer, when an error occurs during a data transfer, error messages are only displayed on the console once the data transfer is terminated.

If you have changed the baud rate from the default rate, the error message is followed by a message telling you to restore the terminal to the baud rate specified in the configuration register.

Debug Commands

Most ROM monitor debugging commands are functional only when Cisco IOS software has crashed or is halted. If you enter a debugging command and Cisco IOS crash information is not available, you see the following error message:

```
"xxx: kernel context state is invalid, can not proceed."
```

The following are ROM monitor debugging commands:

- **stack** or **k**—Produces a stack trace; for example:

```
rommon 6> stack
Stack trace:
PC = 0x801111b0
Frame 00: FP = 0x80005ea8    PC = 0x801111b0
Frame 01: FP = 0x80005eb4    PC = 0x80113694
Frame 02: FP = 0x80005f74    PC = 0x8010eb44
Frame 03: FP = 0x80005f9c    PC = 0x80008118
Frame 04: FP = 0x80005fac    PC = 0x80008064
Frame 05: FP = 0x80005fc4    PC = 0xfff03d70
```

- **context**—Displays processor context; for example:

```
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 new config 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 TCP 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

Table D-1 TCP Port Numbers (continued)

Port	Keyword	Description
75	—	Any private dial-out service
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

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