Efficient Networks

Router Family

Technical Reference Guide

Part No. 107-0002-000

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Attn: Customer Service

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CHAPTER 1

INTRODUCTION

This manual contains information on the advanced functions, features, and management of your router. This manual is intended for small and home office users, remote office users, and other networking professionals who are installing and maintaining bridged and routed networks.

It assumes that you have read the User Reference Guide that came with the router and have installed the router as described in that guide. Configuration of network connections, bridging, routing, and security features are essentially the same for all DSL routers, unless otherwise noted.

How This Manual is Organized

This manual is organized in 8 chapters.

- Chapter 1, Introduction - Provides an overview of the scope and layout of the manual as well as conventions and terminology used throughout the manual.
- Chapter 2, Product Overview - Provides an overview of the products and features supported within this document.
- Chapter 3, Installation and Setup - Provides the planning information, configuration procedures, and verification tools to perform the initial setup of the router.
- Chapter 4, System Management - Provides topical and management information on a variety of system features and functions.
- Chapter 5, System Security - Discusses the security features of the router.
- Chapter 6, Connection Management - Provides information for managing the various interfaces of the router.
- Chapter 7, Monitoring System Performance - Provides information on the tools available to monitor the router's operation as well as troubleshooting information.
- Chapter 8, WEB Management Interface - Provides information on the Web Management Interface.

Document Conventions

Table explains the standard conventions used throughout this document.

Table 1-1: Document Conventions

Convention	Description	Example
Boldface	Buttons, check-boxes, or other items that represent selection made from screens or menus.	Click **Apply** to affect the changes
Italics	Keywords, new words, documentation titles, listed parameters, and other terms of special interest.	...saves the *dhcp.cfg* file.
`Code`	Command, parameter, keyword, value, or other user-entered text.	`set timezone`
>	Menu item. Indented > represent sub-menu selections.	> System > Password
| (vertical bar)	Delineates valid options of which one may be entered/selected.	*enable* | *disable*
<*variable*>	Indicates a field that requires information supplied by the user.	user add user <*username*>

Table 1-2 lists common abbreviations.

Table 1-2: Common Abbreviations

AAL	ATM Adaptation Layer
AAL2	ATM Adaptation Layer 2
AAL5	ATM Adaptation Layer 5
ADPCM	Adaptive Differential Pulse Code Modulation
ADSL	Asymmetric Digital Subscriber Line
ARP	Address Resolution Protocol
ATE	ATM Terminating Equipment (SONET)
ATM	Asynchronous Transfer Mode
ATMF BLES	ATM Forum Broadband Loop Emulation Service
BCD	Binary Coded Decimal

Table 1-2: Common Abbreviations

BER	Basic Encoding Rules or Bit Error Rate
B-HLI	Broadband High Layer Information
B-ICI	Broadband Intercarrier Interface
B-ISSI	Broadband Inter-Switching System Interface
B-LLI	Broadband Low Layer Information
BOM	Beginning of Message
BUS	Broadcast Unknown Server
CBR	Constant Bit Rate
CDV	Cell Delay Variation
CLI	Command Line Interface
CLP	Cell Loss Priority
CMISE	Common Management Information Service Element
CNM	Customer Network Management
CPCS	Common Part Convergence Sublayer
CPE	Customer Premises Equipment
CPI	Common Part Indicator
CRF(VC)	Virtual Channel Connection Related Function
CRF(VP)	Virtual Path Connection Related Function
CRS	Cell Relay Service
CS	Convergence Sublayer
EOM	End of Message
GUI	Graphical User Interface
HEC	Header Error Control
IETF	Internet Engineering Task Force
IPX	Internetwork Packet Exchange
LAN	Local Area Network
LCD	Loss of Cell Delineation
LOF	Loss of Frame (UNI Fault Management)

Table 1-2: Common Abbreviations

LOP	Loss of Pointer (UNI Fault Management)
LOS	Loss of Signal (UNI Fault Management)
MAC	Media Access Control
NG-IAD	Next Generation - Integrated Access Device
NIU	Network Interface Unit
OAM	Operations and Management
OCD	Out-of-Cell Delineation
PCM	Pulse Code Modulation
PCR	Peak Cell Rate
POST	Power-On Self Test
POTS	Plain Old Telephone System
PTI	Payload Type Identifier
PVC	Permanent Virtual Connection
QoS	Quality of Service
RIP	Routing Information Protocol
SAAL	Signalling ATM Adaptation Layer
SCR	Sustainable Cell Rate
SDU	Service Data Unit
SIR	Sustained Information Rate
SNMP	Simple Network Management Protocol
SVC	Switched Virtual Connection
UME	UNI Management Entity
VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VCL	Virtual Channel Link
VP	Virtual Path

Table 1-2: Common Abbreviations

VPCI	Virtual Path Connection Identifier
VPI	Virtual Path Identifier
WMI	Web Management Interface

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CHAPTER 2

PRODUCT OVERVIEW

This chapter provides background information applicable to the Efficient Networks Router Family. These topics include:

- WAN Interfaces
- Virtual Connections
  - ATM
  - Routing and Bridging
- System Interoperability
- Protocol Conformance
- Encapsulation Options

WAN Interfaces

Routers are available whose WAN interfaces conform to various DSL standards. The WAN interface of the router is displayed on the Web Management Router Information Page or on the via the command line interface each time the router reboots, as in the following SHDSL example:

```
Efficient 5950 G.SHDSL [ATM] Router (120-5950-001) v6.0.0 Ready

Username:
```

ADSL

ADSL (Asymmetric DSL) Delivers high-speed data and voice service over the same line. Speeds are determined by the distance from the CO; as the distance increases, the speed available decreases.

- Downstream Speed - 1.5 Mbps to 8 Mbps
- Upstream Speed - 64 Kbps to 800 Kbps
- Max. Distance From CO - 18,000 ft. (3.4 miles)*
- Key Applications - Small businesses and home applications, where downstream speeds are more important than upstream (surfing the web, for example)

G.Lite (gee'-dot-light)

G.Lite is a variation on ADSL; DSL that the end user can install and configure. It is not yet fully plug and play, and has lower speeds than full-rate ADSL.

- Downstream Speed - 1.5 Mbps
- Upstream Speed - 384 Kbps
- Max. Distance From CO - 18,000 ft. (3.4 miles)*
- Key Applications - Consumer Internet access

SDSL

SDSL (Symmetric DSL) Downstream speed is the same as upstream. Does not support voice connections on the same line. Speeds are determined by the distance from the CO; as the distance increases, the speed available decreases.

- Speeds - 160 Kbps to 2.3 Mbps
- Max. Distance From CO - 22,000 ft. (4.1 miles)*
- Key Applications - Business Internet access

IDSL

IDSL (ISDN DSL) A hybrid of ISDN and DSL; it's an always on alternative to dial up ISDN. Does not support voice connections on the same line.

- Speed - 144 Kbps
- Max. Distance From CO - 35,000 ft. (6.6 miles)*
- Key Applications - As an alternate solution: it has a longer range than other DSLs, and is more affordable than dial-up ISDN.

SHDSL

SHDSL (Symmetric high-bit-rate DSL) Standards-based symmetrical DSL that will become widely used, particularly for business. It uses only a single copper pair but can be doubled to two pair for twice the bandwidth.

- Speed - 2.31 Mbps over single pair and 4.6 Mbps over two pair
- Max. Distance From CO - 20,000 ft. (3.78 miles)* and more
- Key Applications - low frequencies. Small and mid-sized business and enterprise branch offices.

VDSL

VDSL (Very high-bit-rate DSL) Still in an experimental phase, this is the fastest DSL, but deliverable over short distance from the CO.

- Downstream Speed - 13 to 52 Mbps
- Upstream Speed - 16 Mbps upstream
- Max. Distance From CO - 4,000 ft. (three quarters of a mile)*
- Key Applications - Carry high-bandwidth over a short distance.

VoDSL

A Voice over DSL (VoDSL) router allows the delivery of both telephony (voice) and data services over a single DSL line. It acts as an Integrated Access Device (IAD), residing on the customer premises and connecting to a DSL circuit. As such, it serves as a circuit/packet gateway and provides standard telephone service as well as Internet service via an Ethernet connection. Thus, the user has access to toll-quality telephone lines and continuous, high-speed Internet and remote LAN services over a single copper loop.

Key Applications - Small businesses that can balance a need for several phone extensions against their Internet connectivity needs.

Virtual Connections

The router's wide area network (WAN) interface uses Asynchronous Transfer Mode (ATM) virtual connections (VCs) to transport data. The system provides unlimited VC support.

ATM

Asynchronous Transfer Mode (ATM) is a networking technology that provides support for a wide variety of services and applications.

ATM is based on the transfer of fixed-length cells (53-byte) containing a header and an information field. The header is used to route the cells through the ATM network backbone. ATM defines the connections by two main parameters:

- Virtual Path Identifier (VPI) - The VPI is an 8-bit field in the header of an ATM cell.
- Virtual Channel Identifier (VCI) - The VCI is a 16-bit field in the header of an ATM cell.

These parameters, used together, provide information that identifies the cell's destination as it passes through ATM switches.

When there is no data to transfer, the ATM link (endpoint-to-endpoint) will send cells across the link until data is present; at that point, the data is incorporated into the stream of cells. When multiple VCs are needed simultaneously, the data is multiplexed to share the link bandwidth.

Routing and Bridging

The 5900 Series Business Gateway does not operate in an explicit bridging or routing mode, but can operate as a bridge, as a router, or as both as defined by the configuration of the specified protocol. The following sections describe routing and bridging and how the two functions operate together.

Routing

Routing is the process that determines where data is sent. A router can route user data from source to destination over different LAN and WAN links. Routing relies on routing address tables to determine the best path for each packet to take.

The routes within a routing address table are established in two ways:

- You can enter specific static routes. For each route, you enter the address for a remote destination with path details and a value for the perceived cost of that route (path latency).
- The routing tables can also be built dynamically; i.e., the location of remote stations, hosts, and networks are updated from broadcast packet information.

Routing offers advantages over bridging because:

- It limits broadcasts to the local LAN segment.
- It limits the protocols that are routed beyond the LAN segment.
- Routed protocols allow networks to grow as large as needed.
- Filters and firewalls can provide screens for improved security and managed traffic flow.

Numerous network protocols have evolved, and within certain protocol suites are associated protocols for routing, error handling, network management, etc. The following chart lists networking protocols and associated protocols supported by the router.

Table 2-1: Network Protocols

Network Protocol	Associated Protocols	Description
IP (Internet Protocol)	RIP (Routing Information Protocol)	Maintains a map of the network
	ARP (Address-Resolution Protocol)	Maps IP addresses to data-link addresses
	RARP (Reverse Address Resolution Protocol)[a]	Maps data-link addresses to IP addresses
	ICMP (Internetwork Control Message Protocol)	Diagnostic and error reporting/recovery
	SNMP (Simple Network Management Protocol)	Network management
IPX (Internet Packet Exchange)	RIP (Routing Information Protocol)[b]	Maintains a map of the network
	SAP (Service Advertising Protocol)	Distributes information about service names and addresses

[a] Used only during a network boot.
[b] IPX-RIP is a different protocol from IP-RIP and it includes time delays.

Bridging

Bridging connects two or more LANs so that all devices share the same logical LAN segment and network numbers. Transparent bridging allows locally connected devices to send frames to all devices as if they were local.

The MAC layer header contains source and destination addresses used to transfer frames. An address table is dynamically built and updated with the logical port a device is connected to as frames are received.

Bridging has these capabilities:

- Allows protocols that cannot be routed (such as NETBIOS) to be forwarded.
- Allows optimizing internetwork capacity by localizing traffic on LAN segments.
- Extends the physical reach of networks beyond the limits of each LAN segment.
- Bridge filtering may increase network security.

Our bridging support includes the IEEE 802.1D standard for LAN-to-LAN bridging and the Spanning Tree Protocol for interoperability with other vendors' bridge/routers. Bridging is provided over PPP as well as adjacent LAN ports.

Bridge-Only Units

A series of bridge-only units is available, both upgradable and non-upgradable. An upgradable bridge can be upgraded to a router; a non-upgradable bridge cannot.

These bridge-only units are pre-configured; no further configuration is required. The unit comes up in bridge mode automatically.

Upgrading an upgradable bridge to become a router requires the addition of a software option key. The software option key turns on the IP Routing feature.

Bridge Filtering

You can control the flow of packets through the router using bridge filters. The filters can "deny" or "allow" packets to cross the network based on the content of the packets. This feature lets you restrict or forward messages with a specified address, protocol, or data content. Common uses are to prevent access to remote networks, control unauthorized access to the local network, and limit unnecessary traffic.

For example, to restrict remote access for specific users, you could define bridge filters using the local MAC address of each user to be restricted. Each bridge filter is specified as a "deny" filter based on the MAC address and position of the address within the packet. Deny filtering mode is then enabled to initiate bridge filtering. While in deny mode, all packets containing one of the filtered MAC addresses are denied bridging across the router.

Similarly, protocol filtering can be used to prevent a specific protocol from being bridged. In this case, the protocol ID field in a packet is used to deny or allow a packet. You can also restrict the bridging of specific broadcast packets.

For a further discussion of bridge filtering, see "Bridge Filtering" on page 5-75.

When to Use Routing or Bridging or Both

The following charts describe the operational characteristics of the router when you enable routing, bridging, or both routing and bridging.

Table 2-2: Routing vs. Bridging Comparison

IP/IPX Routing On	Bridging to/from Remote Router Off
Data packets carried	IP (TCP, UDP), IPX
Operational characteristics	Basic IP, IPX connectivity
Typical usage	When only IP/IPX traffic is to be routed and all other traffic is to be ignored. For IP, used for Internet access.
IP/IPX Routing On	**Bridging to/from Remote Router On**
Data packets carried	IP/IPX routed; all other packets bridged.
Operational characteristics	IP/IPX routing; allows other protocols, such as NetBEUI (that can't be routed), to be bridged.
Typical usage	When only IP/IPX traffic is to be routed but some non-routed protocol is required. Used for client/server configurations.
IP/IPX Routing Off	**Bridging to/from Remote Router On**
Data packets carried	All packets bridged.
Operational characteristics	Allows use of protocols that can't be routed (such as NetBEUI).
Typical usage	Peer-to-peer bridging and when the remote end supports only bridging.

How Routing and Bridging Work Together

The router follows these rules when operating as both a router and a bridge:

- The router operates as a router for network protocols that are enabled for routing (IP or IPX).
- The router operates as a bridge for protocols that are not supported for routing.
- Routing takes precedence over bridging; i.e., when routing is active, the router uses the packet's protocol address information to route the packet.
- If the protocol is not supported, then bridging uses the MAC address information to forward the packet.

Routing and Bridging Controls

The router can be configured to perform general routing and bridging while allowing you to set specific controls.

- One remote router can be designated as the outbound default bridging destination. All outbound bridging traffic with an unknown destination is sent to the default bridging destination.
- Bridging can be enabled or disabled for specific remote routers.
- Routing can be enabled or disabled for the entire router and for individual remotes.

Operation of the router is influenced by routing and bridging controls and filters set during router configuration as well as automatic spoofing and filtering performed by the router. For example, general IP or IPX routing, and routing or bridging from specific remote routers are controls set during the configuration process.

Spoofing and filtering, which minimize the number of packets that flow across the WAN, are performed automatically by the router. For example, RIP routing packets and certain NetBEUI packets are spoofed even if only bridging is enabled.

System Interoperability

The router uses industry-wide standards to ensure compatibility with routers and equipment from other vendors. To inter-operate, the router supports standard protocols on the physical level, data link level, and network level. For two systems to communicate directly, they must use the same protocol at each level.

Level	Interoperability	Determined by
Physical media	Hardware and electrical signaling	Router Ethernet and modem hardware interfaces for copper wire or fiber cable
Data link	Packet transmission method (frame type or encapsulation method)	Router hardware and software kernel. Can be Ethernet, ATM, or Frame Relay
Network layer	Network protocol	Router configuration. Can be IP or IPX

The data-link protocol level defines the transmission of data packets between two systems over the LAN or WAN physical link. The frame type or encapsulation method defines a way to run multiple network-level protocols over a single LAN or WAN link. Most protocols do not support negotiable options, except for PPP.

The router supports both ATM (Asynchronous Transfer Mode) and Frame Relay transmission. ATM transport uses fixed-length cells; Frame Relay transport uses variable-length packets.

The router supports the following WAN encapsulations:

- PPP (VC multiplexing)
- PPP (LLC multiplexing)
- PPPoE (PPP over Ethernet)
- RFC 1483 (for ATM)
- RFC 1483 with MAC encapsulated routing (for ATM)
- FRF8 (for ATM)
- RFC 1490 (for Frame Relay)
- RFC 1490 with MAC encapsulated routing (for Frame Relay)
- The packet formats for these encapsulation methods are given in "Encapsulation Options" on page 2-11.

Protocol Conformance

The router conforms to RFCs designed to address performance, authentication, and multi-protocol encapsulation. The following RFCs are supported:

RFC 1058 Routing Information Protocol (RIP)
RFC 1144 Compressing TCP/IP headers (Van Jacobson)
RFC 1220 Bridging Control Protocol (BNCP)
RFC 1332 IP Control Protocol (IPCP)
RFC 1334 Password Authentication Protocol and Challenge Handshake Authentication Protocol (PAP/CHAP)
RFC 1389 RIP2
RFC 1483 Multiprotocol Encapsulation over ATM Adaptation Layer 5
RFC 1490 Multiprotocol Interconnect over Frame Relay
RFC 1542 DHCP Relay Agent
RFC 1552 Novell IPX Control Protocol (IPXCP)
RFC 1577 Classical IP and ARP over ATM
RFC 1631 Network Renumbering
RFC 1661 Point-to-Point Protocol (PPP)
RFC 1723 RIP Version 2
RFC 1769 Simple Network Time Protocol (SNTP)
RFC 1877 Automatic IP / DNS
RFC 1962 PPP Compression Control Protocol (CCP)
RFC 1969 PPP DES Encryption Protocol (ECP)
RFC 1973 PPP in Frame Relay

RFC 1974 PPP Stac LZS Compression Protocol
RFC 1990 Multi-Link Protocol (MLP)
RFC 1994 User Authentication PAP / CHAP
RFC 2104 HMAC: Keyed-Hashing for Message Authentication
RFC 2131 Dynamic Host Configuration Protocol (DHCP)
RFC 2132 DHCP Client
RFC 2364 PPP over AAL5
RFC 2401 Security Architecture for the Internet Protocol
RFC 2402 IP Authentication Header
RFC 2403 The Use of HMAC-MD5-96 within ESP and AH
RFC 2404 The Use of HMAC-SHA-1-96 within ESP and AH
RFC 2405 The ESP DES-CBC Cipher Algorithm With Explicit IV
RFC 2406 IP Encapsulating Security Payload (ESP)
RFC 2407 The Internet IP Security Domain of Interpretation for ISAKMP
RFC 2408 Internet Security Association and Key Management Protocol (ISAKMP)
RFC 2409 The Internet Key Exchange (IKE)
RFC 2410 The NULL Encryption Algorithm and Its Use with IPSec
RFC 2412 The OAKLEY Key Determination Protocol
RFC 2419 PPP DES Encryption v2
RFC 2451 The ESP CBC-Mode Cipher Algorithms

IP Routing

IP routing support, in conformance with RFC 791, provides the ability to process TCP/IP frames at the network layer for routing. IP routing support includes the Routing Interface Protocol (RIP), in conformance with RFC 1058 (RIP v.1) and RFC 1723 (RIP v.2).

IPX Routing

IPX routing conforms to the Novell® NetWare™ IPX Router Development Guide, Version 1.10.

Encapsulation Options

This section describes the packet format for each encapsulation option supported by the router.

☞ **NOTE:**

The same encapsulation method must be used by both ends of the connection (the router and the DSLAM).

PPP

This protocol uses VC multiplexing, as defined in RFC 2364; it dedicates a virtual circuit to PPP traffic only. (The other encapsulation method defined in RFC 2364, LLC multiplexing, is described in the next section, PPPLLC.)

Each packet begins with a one- or two-byte protocol ID. Typical IDs are:

0xc021	LCP
0x8021	IPCP
0x0021	IP
0x002d	Van Jacobson compressed TCP/IP
0x002f	Van Jacobson uncompressed TCP/IP
0x8031	Bridge NCP
0x0031	Bridge Frame

☞ **NOTE:**

With PPP over ATM, the address and control fields (i.e., FF03) are never present; this also is the case for LCP packets.

PPPLLC

This protocol (LLC-multiplexed) allows PPP traffic to be carried simultaneously with other traffic on a single virtual circuit (as opposed to the PPP method of encapsulation - VC multiplexing - which dedicates a virtual circuit to PPP traffic only).

Each PPP packet is prepended with the sequence 0xFEFE03CF. Thus, an LLC packet has the format: 0xFEFE03CF 0xC021.

RFC 1483 or RFC 1490

Bridging

User data packets are prepended by the sequence 0xAAAA0300 0x80c20007 0x0000 followed by the Ethernet frame containing the packet.

802.1D Spanning Tree packets are prepended with the header 0xAAAA0300 0x80C2000E.

Routing

IP packets are prepended with the header 0xAAAA0300 0x00000800.

IPX packets are prepended with the header 0xAAAA0300 0x00008137.

MAC Encapsulated Routing: RFC 1483MER (ATM) or RFC 1490MER (Frame Relay)

MER encapsulation allows IP packets to be carried as bridged frames, but does not prevent bridged frames from being sent as well, in their normal encapsulation format: RFC 1483 (ATM) or RFC 1490 (Frame Relay).

If IP routing is enabled, then IP packets are prepended with the sequence 0xAAAA0300 0x80c20007 0x0000 and sent as bridged frames. If IP routing is not enabled, then the packets appear as bridged frames.

FRF8

IP packets have prepended to them the following sequence: 0x03CC.

☞ **NOTE:**

This protocol allows sending ATM over Frame Relay.

rawIP

IP packets do not have any protocol headers prepended to them; they appear as IP packets on the wire. Only IP packets can be transported since there is no possible method to distinguish other types of packets (bridged frames or IPX).

☞ **NOTE:**

This protocol allows sending ATM over Frame Relay.

CHAPTER 3

INSTALLATION AND SETUP

This chapter describes the steps necessary to plan and deploy your router with basic operation. Within this chapter, the following steps will be followed to plan for and configure your router:

- Planning the Configuration
- Configuring Your Computer
- Installation
- Establishing a Connection
  - Connecting through the Web Management Interface
  - Accessing the Command Line Interface
- Configuring the Router
- Verify the Router Configuration

Planning the Configuration

This section describes the basic information you need before you can begin configuring your router. The basic configuration tasks can be performed using the Command Line Interface described in this manual or the graphic interface described in the User Reference Guide (co-located on this CD-ROM). The basic configuration information is the same for either interface. The basic configuration tasks include the following:

- Setting names, passwords, PVC numbers, and link and network parameters
- Configuring specific protocol requirements, such as IP or IPX addresses and IP protocol controls
- Activating bridging and routing protocols
- Enabling the Internet firewall filter with IP routing

Remote Routers

Throughout this document, many references are made to "local routers" and "remote routers." A local router is the router you are configuring, and the is any other router that connect to the local router. For additional information on Remote Routers, see “Controlling Remote Management” on page 5-15.

Local router. Router that you are configuring. Also referred to as target router.

Remote routers. All the routers to which the local (target) router may connect.

Remote router database. Database which resides in the local router and contains information about the remote routers to which the local router can connect.

Figure 3-1 illustrates these terms.As shown in the illustration, the remote router database in the local router contains an entry for each remote router. A remote router entry defines:

- Connection parameters
- Security features
- Route addressing and bridging functions

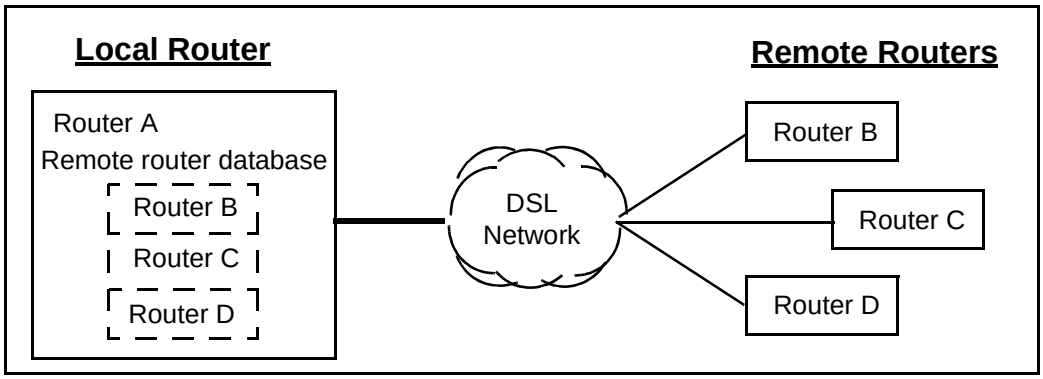


Figure 3-1: Local and Remote Router Overview

The commands that define information for a remote router entry start with the word remote and end with the name of the remote entry. Most of these commands are described in the Command Line Interface Guide - Chapter 6, Remote Commands.

For procedures on managing remote use, see “Controlling Remote Management” on page 5-15.

Protocols to be Used

The information needed to configure the router depends on the link protocol and network protocols that are to be used. The link protocol and network protocols used are generally determined by your Network Service Provider.

This section is organized into sub-sections that apply to specific protocols.

If you are using Link and Network Protocols:

PPP with:

- IP Routing, see "IP Routing Network Protocol" on page 3-3.
- IPX Routing, see "IPX Routing Network Protocol" on page 3-6.
- Bridging, see "Bridging Network Protocol" on page 3-8.

RFC 1483 or RFC 1490 with:

- IP Routing, see "IP Routing Network Protocol" on page 3-9.
- IPX Routing, see "IPX Routing Network Protocol" on page 3-10.
- Bridging, see "Bridging Network Protocol" on page 3-12.

RFC 1483 MER or RFC 1490 MER (MAC Encapsulated Routing) with:

- IP Routing, see "IP Routing Network Protocol" on page 3-12.

PPP Link Protocol (over ATM or Frame Relay)

The PPP link protocol is an encapsulation method that can be used over ATM or over Frame Relay. For PPP over Ethernet (PPPoE), see "PPPoE (PPP over Ethernet)" on page 6-41.

PPP over ATM and PPP over Frame Relay use different connection identifiers:

- ATM uses VPI/VCI numbers.
- Frame Relay uses a DLCI number.

IP Routing Network Protocol

To configure the IP network protocol and PPP link protocol, you need the following information.

System Names and Authentication Passwords for the Local Router and All Remote Routers

- For the Local Router:

  You define a system name and authentication password for the local router. Remote routers check the system name and authentication password to authenticate the local router.

- For Remote Routers:

  Although the system names and authentication passwords for the remote routers are defined by the service provider, you must have this information because the local router uses it to authenticate the remote router. The name and password are used in both PAP and CHAP authentication. To see how this information is used, see "PAP/CHAP Security Authentication" on page 5-20.

☞ **NOTE:**

If the service provider does not support the authentication of remote routers by the local router, use the command remote disauthen *<remoteName>* to disable the authentication process.

For an ATM router, its VPI and VCI numbers

ATM uses two connection identifiers that describe the PVC (Permanent Virtual Circuit). These identifiers are the VPI (Virtual Path Identifier) and the VCI (Virtual Channel Identifier). Your router may have been preconfigured with VPI/VCI numbers. If not, you need to get these numbers from your service provider.

If you are connecting to multiple remote sites, you need the unique VPI and VCI numbers that identify each remote destination.

For a Frame Relay router, its DLCI number

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

DNS Internet Account Information (optional)

The Domain Name Service (DNS) maps host names to IP addresses. DNS is performed by Domain Name Servers. The router can get DNS information automatically. Or, you can choose to configure DNS manually. Consult with your Network Service Provider to determine if you need to enter the following information:

- DNS server address
- DNS second server address
- DNS domain name

IP Routing Addresses

- For the Ethernet interface:

  Ethernet IP Address (Local LAN)

  An Ethernet LAN IP address and subnet mask are required for the router's local Ethernet LAN connection. This information is defined by the user or your network administrator.

☞ **NOTE:**

An Ethernet route is usually defined when there are multiple routers on the Ethernet that cannot exchange routing information. This feature is only used in special circumstances.

- For the WAN interface:

  The following information is defined by your network service provider.

  Source (Local) WAN Port Address

  If Network Address Translation (NAT) is enabled, you must specify a source WAN IP address for the WAN connection to the remote router if IP address negotiation under PPP does not provide one. Check with your network administrator for details on whether the router must communicate in numbered or unnumbered mode and which addresses are required.

  Remote WAN Address

  You may need to specify a remote WAN IP address for the WAN connection to the remote router depending on IP address negotiation under PPP. Check with your network administrator for details on whether the router must communicate in numbered or unnumbered mode and which addresses are required.

  TCP/IP Remote Routes

  An IP route includes an IP address, subnet mask, and metric (a number representing the perceived cost to reach the remote network or station).

  A TCP/IP Default Route

  A default route should be designated in the routing table for all traffic that cannot be directed to other specific routes. Define the default route to a remote router or, in special circumstances, define an Ethernet gateway. There can be *only one* default route specified.

IPX Routing Network Protocol

System Names and Authentication Passwords for the Local Router and All Remote Routers

- For the Local Router:

  You define a system name and authentication password for the local router. Remote routers check the system name and authentication password to authenticate the local router.

- For Remote Routers:

  Although the system names and authentication passwords for the remote routers are defined by the service provider, you must have this information because the local router uses it to authenticate the remote router. The name and password are used in both PAP and CHAP authentication. To see how this information is used, see "PAP/CHAP Security Authentication" on page 5-20.

☞ **NOTE:**

If the service provider does not support the authentication of remote routers by the local router, use the command remote disauthen <*remoteName*> to disable the authentication process.

For an ATM router, its VPI and VCI numbers

ATM uses two connection identifiers that describe the PVC (Permanent Virtual Circuit). These identifiers are the VPI (Virtual Path Identifier) and the VCI (Virtual Channel Identifier). Your router may have been preconfigured with VPI/VCI numbers. If not, you need to get these numbers from your service provider.

If you are connecting to multiple remote sites, you need the unique VPI and VCI numbers that identify each remote destination.

For a Frame Relay router, its DLCI number

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

IPX routing entries

IPX routes define the paths to specific destinations. Routers need them so servers and clients can exchange packets. A path to a file server is based on the Internal Network Number of the server. A path to a client is based on the External Network Number (Ethernet) of the client.

You need the following information (most likely from your network administrator) for IPX routing.

Internal Network Number

It is a logical network number that identifies an individual Novell server. It specifies a route to the services (i.e., file services, print services) that Novell offers. It must be a unique number.

External Network Number (IPX Network Number)

It refers to a physical LAN/wire network segment to which servers, routers, and PCs are connected (Ethernet cable-to-router segment). It must be a unique number.

WAN Network Number

Important: This number is part of the routing information. It only identifies the WAN segment between the two routers. Note that only those two routers need to have the WAN Network Number configured.

Service Advertisement Protocol (SAP)

SAP entries should reflect primary logon servers for the clients on the local LAN. Only the servers on the remote side of the link have to be entered. Local servers do not need to be entered.

Frame Type

With local servers on your LAN, make sure to select the proper frame type for the IPX network number. To determine this, consult with your network administrator. When you have only NetWare clients on your LAN, keep the default (802.2) selected as most clients can support any type. The frame type choices are:

802.2	Default recommended by Novell
802.3	Other most common type
DIX	For DEC, Intel, Xerox; this setting is also referred to as “Ethernet II”, and it is becoming obsolete.

Bridging Network Protocol

To configure bridging as the network protocol and PPP as the link protocol, you need the following information:

System Names and Authentication Passwords for the Local Router and All Remote Routers

- For the Local Router:

  You define a system name and authentication password for the local router. Remote routers check the system name and authentication password to authenticate the local router.

- For Remote Routers:

  Although the system names and authentication passwords for the remote routers are defined by the service provider, you *must* have this information because the local router uses it to authenticate the remote router. The name and password are used in both PAP and CHAP authentication. To see how this information is used, see “PAP/CHAP Security Authentication” on page 5-20.

☞ **NOTE:**

If the service provider does not support the authentication of remote routers by the local router, use the command remote disauthen <*remoteName*> to disable the authentication process.

For an ATM router, its VPI and VCI numbers

ATM uses two connection identifiers that describe the PVC (Permanent Virtual Circuit). These identifiers are the VPI (Virtual Path Identifier) and the VCI (Virtual Channel Identifier). Your router may have been preconfigured with VPI/VCI numbers. If not, you need to get these numbers from your service provider.

If you are connecting to multiple remote sites, you need the unique VPI and VCI numbers that identify each remote destination.

For a Frame Relay router, its DLCI number

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

DNS Internet Account Information (optional)

The Domain Name Service (DNS) maps host names to IP addresses. DNS is performed by Domain Name Servers. The router can get DNS information automatically. Or, you can choose to configure DNS manually. Consult with your Network Service Provider to determine if you need to enter the following information:

- DNS server address
- DNS second server address
- DNS domain name

RFC 1483/RFC 1490 Link Protocols

The link protocols RFC 1483 and RFC 1490 are multiprotocol encapsulation methods. RFC 1483 is used over ATM; RFC 1490 is used over Frame Relay.

RFC 1483 and RFC 1490 combined with the IP, IPX, or Bridging network protocols share the same configuration characteristics, except for the connection identifiers: VPI/VCI numbers are used for RFC 1483 and a DLCI number is used for RFC 1490.

IP Routing Network Protocol

To configure the IP network protocol and RFC 1483 or RFC 1490 as the link protocol, you need the following information.

VPI and VCI numbers (for RFC 1483)

The VPI and VCI numbers apply to ATM routers only. Your router may have been preconfigured with VPI/VCI numbers. If not, get these numbers from your Network Service Provider.

If you are connecting to multiple remote sites, get additional VPI and VCI numbers from your Network Service Provider. These numbers identify the remote destination and must be unique for each remote.

DLCI number (for RFC 1490)

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

DNS Internet Account Information (optional)

Consult with your Network Service Provider to determine if you need to enter the following information:

- DNS server address
- DNS second server address
- DNS domain name

IP Routing Entries

- For the Ethernet interface:

  Ethernet IP Address (Local LAN)

  An Ethernet LAN IP address and subnet mask are required for the router's local Ethernet LAN connection. This information is defined by the user or your network administrator.

  TCP/IP Ethernet Routes

  You normally do not need to define an Ethernet IP route. An Ethernet IP route consists of an IP address, a mask, a metric, and a gateway. An Ethernet route is usually defined when there are multiple routers on the Ethernet that cannot exchange routing information.

- For the WAN interface:

  The following information is defined by your Network Administrator.

  Source (Target/Local) WAN Port Address

  If Network Address Translation (NAT) is enabled, you must specify a source WAN IP address for the WAN connection to the remote router.

  If NAT is *not* enabled, you may need to specify a source WAN IP address for the WAN connection to the remote router.

  TCP/IP Remote Routes

  An IP route includes an IP address, subnet mask, and metric (a number representing the perceived cost to reach the remote network or station).

  A TCP/IP Default Route

  A default route should be designated in the routing table for all traffic that cannot be directed to other specific routes. Define the default route to a remote router or, in special circumstances, define an Ethernet gateway. There can be *only one* default route specified.

IPX Routing Network Protocol

To configure IPX as the network protocol and RFC 1483 or RFC 1490 as the link protocol, you need the following information:

VPI and VCI numbers (for RFC 1483)

The VPI and VCI numbers apply to ATM routers only. Your router may have been preconfigured with VPI/VCI numbers. If not, get these numbers from your Network Service Provider.

If you are connecting to multiple remote sites, get additional VPI and VCI numbers from your Network Service Provider. These numbers identify the remote destination and must be unique for each remote.

DLCI number (for RFC 1490)

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

IPX routing entries

IPX routes define the *paths* to specific destinations. Routers need them so servers and clients can exchange packets. A path to a file server is based on the Internal Network Number of the server. A path to a client is based on the External Network Number (Ethernet) of the client.

You need the following information (most likely from your network administrator) for IPX routing.

Internal Network Number

It is a logical network number that identifies an individual Novell server. It specifies a route to the services (i.e., file services, print services) that Novell offers. It must be a unique number.

External Network Number (IPX Network Number)

It refers to a physical LAN/wire network segment to which servers, routers, and PCs are connected (Ethernet cable-to-router segment). It must be a unique number.

WAN Network Number

Important: This number is part of the routing information. It only identifies the WAN segment between the two routers. Note that only those two routers need to have the WAN Network Number configured.

Service Advertisement Protocol (SAP)

SAP entries should reflect primary logon servers for the clients on the local LAN. Only the servers on the remote side of the link have to be entered. Local servers do not need to be entered.

Frame Type

With local servers on your LAN, make sure to select the proper frame type for the IPX network number. To determine this, consult with your network administrator. When you have only NetWare clients on your LAN, keep the default (802.2) selected as most clients can support any type. The frame type choices are:

802.2	Default recommended by Novell
802.3	Other most common type
DIX	For DEC, Intel, Xerox; this setting is also referred to as “Ethernet II”, and it is becoming obsolete.

Bridging Network Protocol

To configure bridging as the network protocol and RFC 1483 or RFC 1490 as the link protocol, you need the following information:

VPI and VCI numbers (for RFC 1483)

The VPI and VCI numbers apply to ATM routers only. Your router may have been preconfigured with VPI/VCI numbers. If not, get these numbers from your Network Service Provider.

If you are connecting to multiple remote sites, get additional VPI and VCI numbers from your Network Service Provider. These numbers identify the remote destination and must be unique for each remote.

For a Frame Relay router, its DLCI number

The DLCI (Data Link Connection Identifier) number applies to Frame Relay routers only. Get your DLCI from your service provider.

DNS Internet Account Information (optional)

The Domain Name Service (DNS) maps host names to IP addresses. DNS is performed by Domain Name Servers. The router can get DNS information automatically. Or, you can choose to configure DNS manually. Consult with your Network Service Provider to determine if you need to enter the following information:

- DNS server address
- DNS second server address
- DNS domain name

MAC Encapsulated Routing

MAC Encapsulated Routing (MER) allows IP packets to be carried as bridged frames (bridged format). The link protocol RFC 1483 with MER (referred to as RFC 1483MER) is a multiprotocol encapsulation method over ATM used by ATM routers. RFC 1490 with MER (referred to as RFC 1490MER) is a multiprotocol encapsulation method over Frame Relay used by Frame-Relay routers.

RFC 1483MER and RFC 1490MER combined with the IP, IPX, or Bridging network protocols share the same configuration characteristics, except for the connection identifiers: VPI/VCI numbers are used for RFC 1483MER and a DLCI number is used for RFC 1490.

IP Routing Network Protocol

VPI and VCI numbers (for RFC 1483MER)

The VPI and VCI numbers apply to ATM routers only. Your router may have been preconfigured with VPI/VCI numbers. If not, get these numbers from your Network Service Provider and then configure them.

If you are connecting to multiple remote sites, get additional VPI and VCI numbers from your Network Service Provider. These numbers identify the remote destination and must, therefore, be unique for each remote.

DLCI number (for RFC 1490MER)

The DLCI number applies to Frame Relay routers only. Your Network Service Provider or your Network Access Provider will provide you with a DLCI (Data Link Connection Identifier). The DLCI is an address identifying your connection.

DNS Internet Account Information (optional)

Consult with your Network Service Provider to determine if you need to enter the following information:

- DNS server address
- DNS second server address
- DNS domain name

IP Routing Entries

- For the Ethernet interface:

  Ethernet IP Address (Local LAN)

  An Ethernet LAN IP address and subnet mask are required for the router's local Ethernet LAN connection. This information is defined by the user or your network administrator.

  TCP/IP Ethernet Routes

  You normally do not need to define an Ethernet IP route. An Ethernet IP route consists of an IP address, a mask, a metric, and a gateway. An Ethernet route is usually defined when there are multiple routers on the Ethernet that cannot exchange routing information between them.

- For the ATM WAN interface:

  The following information is defined by your Network Administrator or the Network Service Provider.

  Source (Target/Local) WAN Port Address and Mask

  You *must* specify a Source WAN IP address for the WAN connection to the remote router (whether or not Network Address Translation is enabled). The Source WAN Address is the address of the local router on the remote network. The mask is the mask used on the remote network. Check with your system administrator for details.

If NAT is *not* enabled, you may need to specify a source WAN IP address for the WAN connection to the remote router.

TCP/IP Remote Routes

If you are using RFC 1483MER or RFC 1490MER, the IP route includes an IP address, subnet mask, metric (a number representing the perceived cost in reaching the remote network or station), and a *gateway*. The gateway address that you enter is the address of a router on the remote LAN. Check with your system administrator for details.

A TCP/IP Default Route

A default route should be designated in the routing table for all traffic that cannot be directed to other specific routes. Define the default route to a remote router or, in special circumstances, define an Ethernet gateway. There can be *only one* default route specified.

Configuring Your Computer

Your computer must be configured to use the TCP/IP protocol suite over the Internet, and to accept DHCP (Dynamic Host Configuration Protocol) address assignments from your router. Although the information and settings required to make such configurations is standard, differences exist amongst the various computer operating systems in how these configurations are presented and established. This section presents the TCP/IP and DHCP configuration screens in the most popular operating systems, to guide the reader through the configuration process for each operating system.

You can skip directly to the instructions for your computer operating system from the following list:

- Microsoft Windows
  - Windows 98
  - Windows NT 4
  - Windows 2000
  - Windows ME
  - Windows XP
- Apple Macintosh
  - Macintosh Classic (Mac OS 9.x or earlier)
  - Mac OS X
- Linux OS

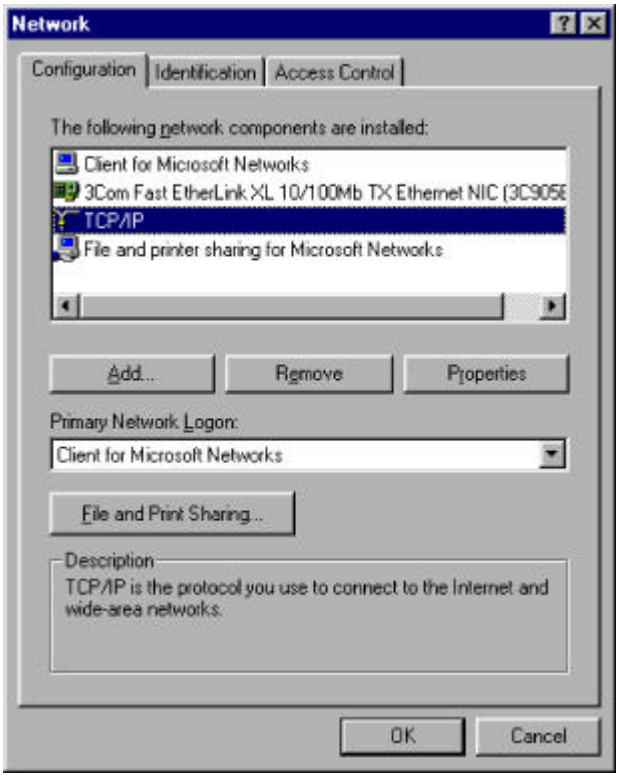
Microsoft Windows

Windows 98

Step 1 On your desktop, right click on the **Network Neighborhood** icon.

Step 2 The *Network* dialog should appear. Under the Configuration tab, from the network components installed, select **TCP/IP**.

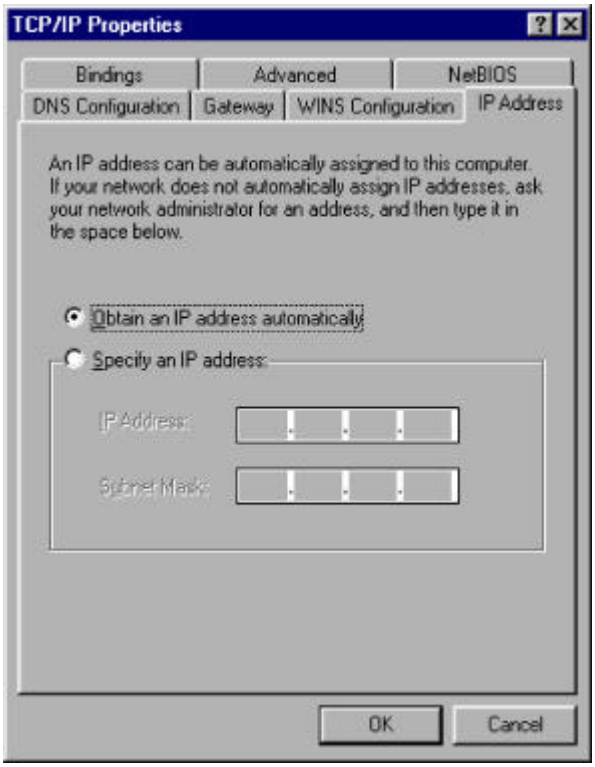
Step 3 Click **Properties** to display TCP/IP properties.



Step 4 In the *TCP/IP Properties* dialog, select the **IP Address** tab.

Step 5 Under the IP Address tab, click to select the option to **Obtain an IP address automatically**.

Step 6 Click **OK**.



Step 7 Click **OK** buttons to close each dialog.

☞ **NOTE:**

You may need to restart your PC for these changes to take effect.

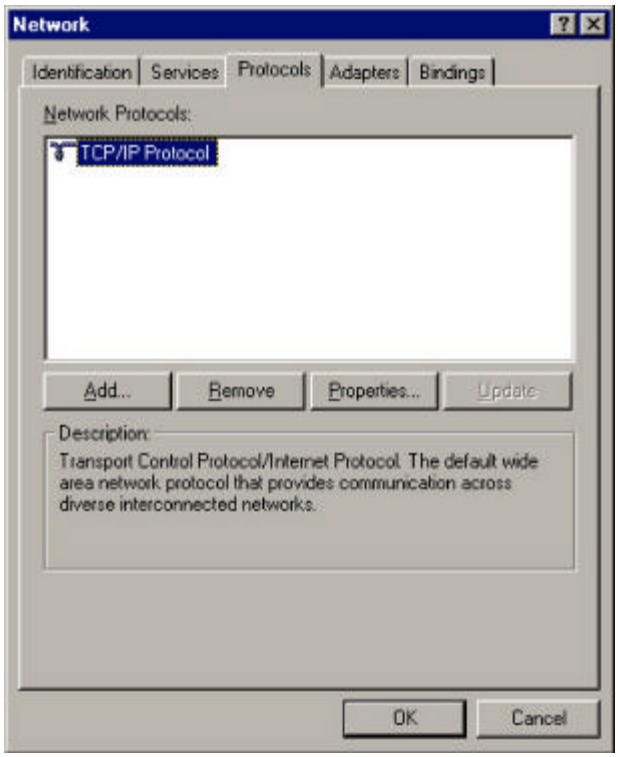
Task Complete

Windows NT 4

Step 1 On your desktop, right click on the **Network Neighborhood** icon.

Step 2 The *Network* dialog should appear. Under the Protocols tab, from the network protocols installed, select **TCP/IP Protocol**.

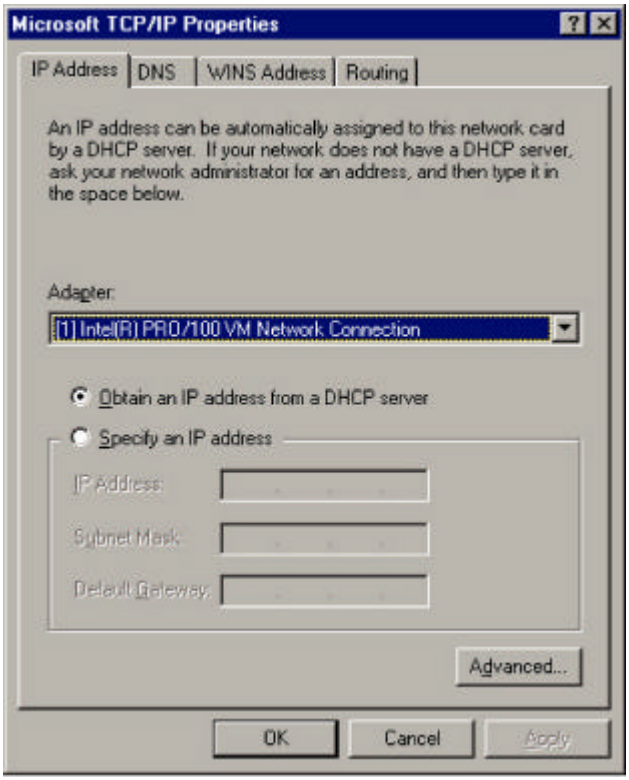
Step 3 Click **Properties** to display TCP/IP properties.



Step 4 In the Microstate *TCP/IP Properties* dialog, select the **IP Address** tab.

Step 5 Under the *IP Address* tab, click to select the option to **Obtain an IP address from a DHCP server**.

Step 6 Click **OK**.



Step 7 Click **OK** buttons to close each dialog.

☞ **NOTE:**
You may need to restart your PC for these changes to take effect.

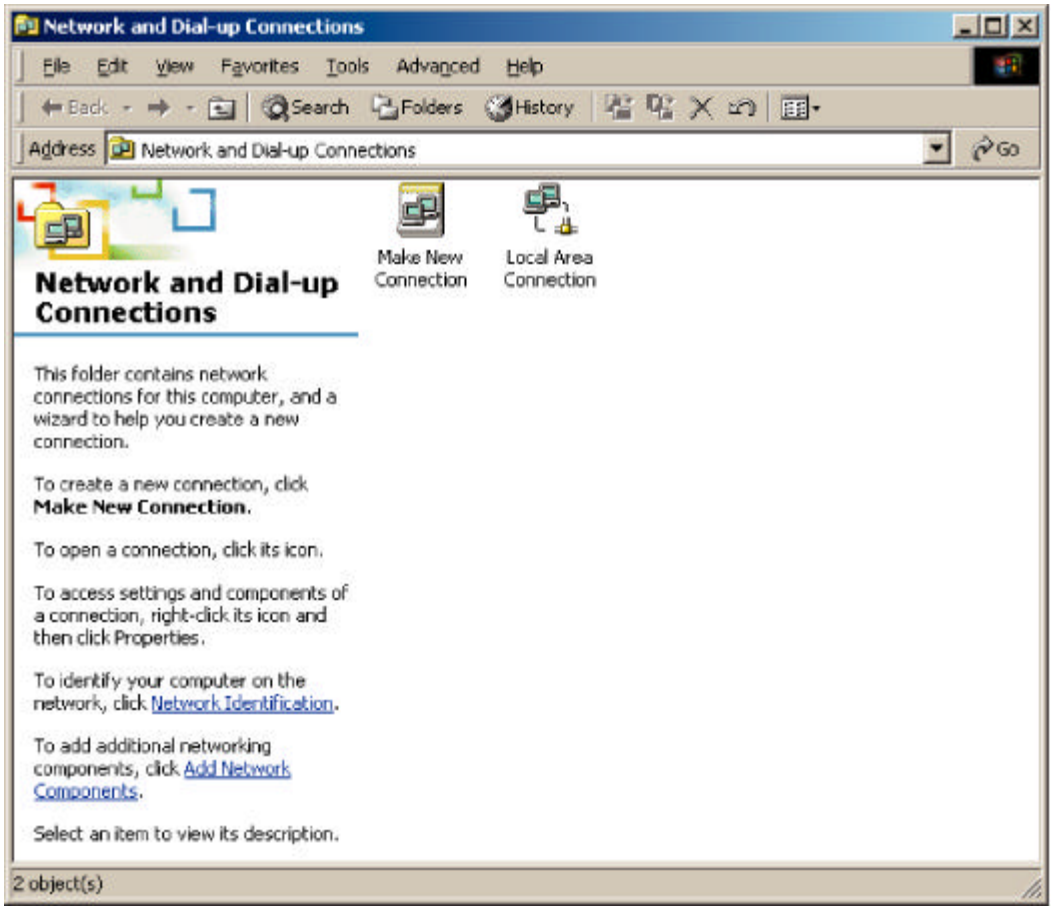
Task Complete

Windows 2000

Step 1 On your desktop, right click on the **My Network Places** icon.

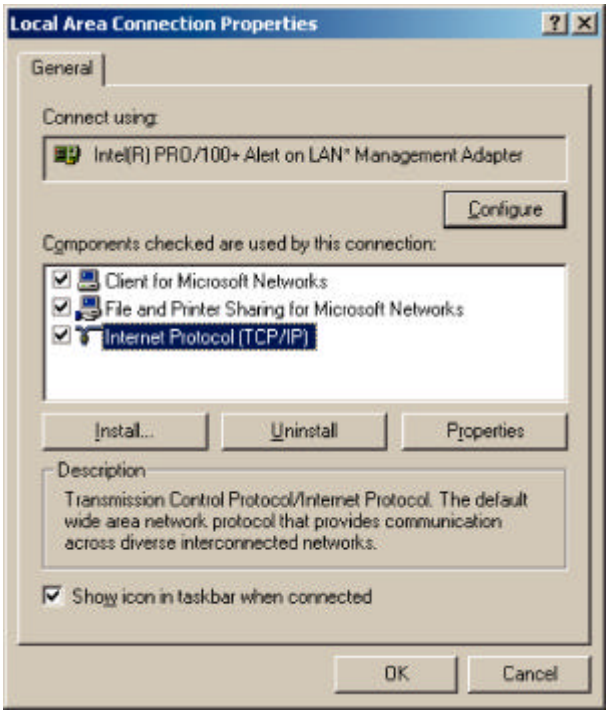
Step 2 The Network and Dial-up Connections window should appear. Right click on the **Local Area Connection** icon.

Step 3 From the menu, select **Properties**.

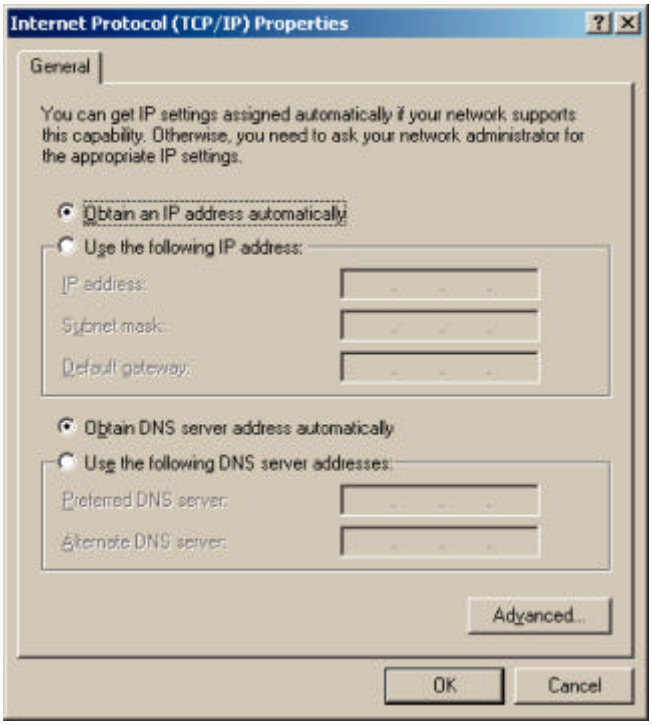


Step 4 The *Local Area Connection Properties* dialog should appear. From the list of components, select **Internet Protocol (TCP/IP)**.

Step 5 Click **Properties**.



Step 6 The *Internet Protocol (TCP/IP) Properties* dialog should appear. Select **Obtain an IP address automatically** and **Obtain DNS server address automatically**.



Step 7 Click **OK**.

Step 8 Click **OK** buttons to close each dialog.

☞ **NOTE:**

You may need to restart your PC for these changes to take effect.

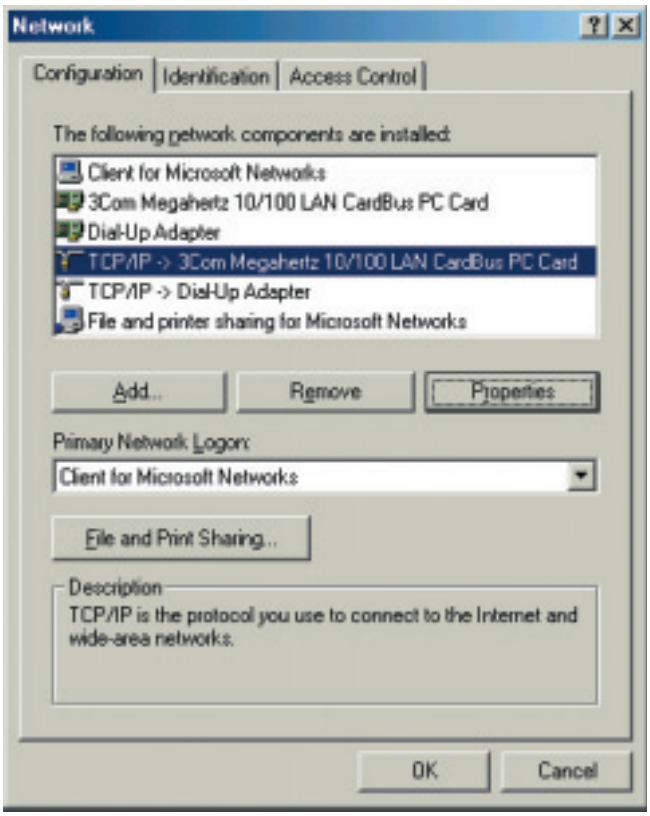
Task Complete

Windows ME

Step 1 On your desktop, right click on the **Network Places** icon (shown below).

Step 2 From the displayed menu, select **Properties**.

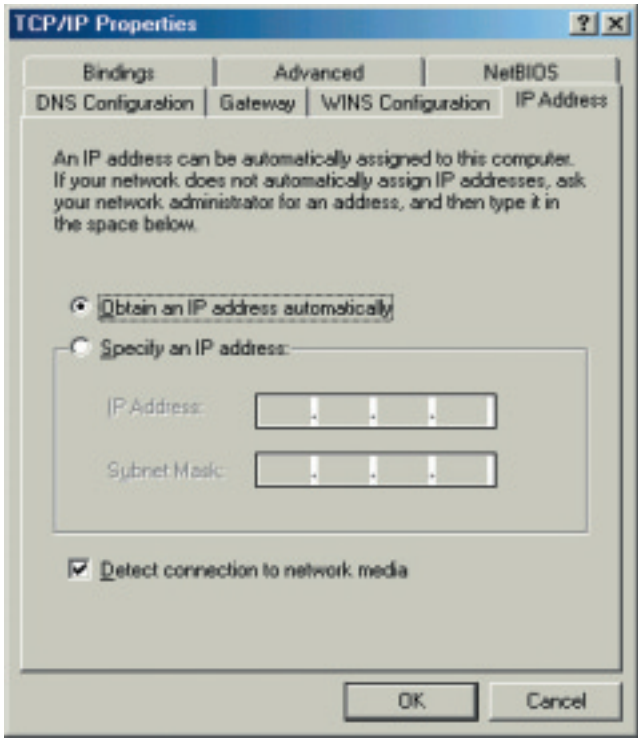
Step 3 The *Network* dialog should appear. Under the *Configuration* tab, from the network components installed, select the **TCP/IP Protocol** associated with your network card (see the example below).



Step 4 Click **Properties** to display *TCP/IP properties*.

Step 5 In the *TCP/IP Properties* dialog, select the **IP Address** tab.

Step 6 Under the *IP Address* tab, click to select the option to **Obtain an IP address automatically**.



Step 7 Click **OK**.

Step 8 Click **OK** buttons to close each dialog.

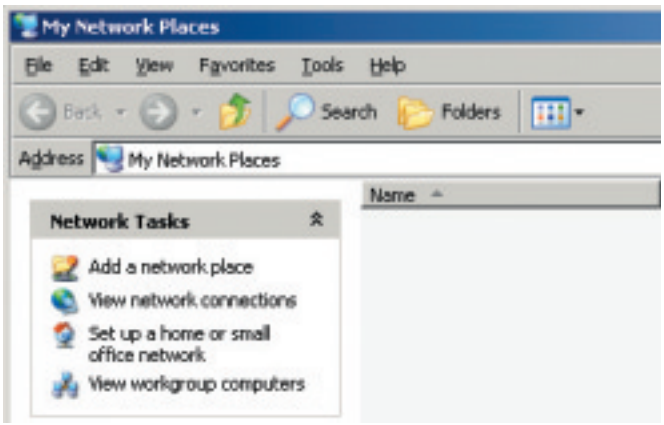
☞ **NOTE:**
You may need to restart your PC for these changes to take effect.

Task Complete

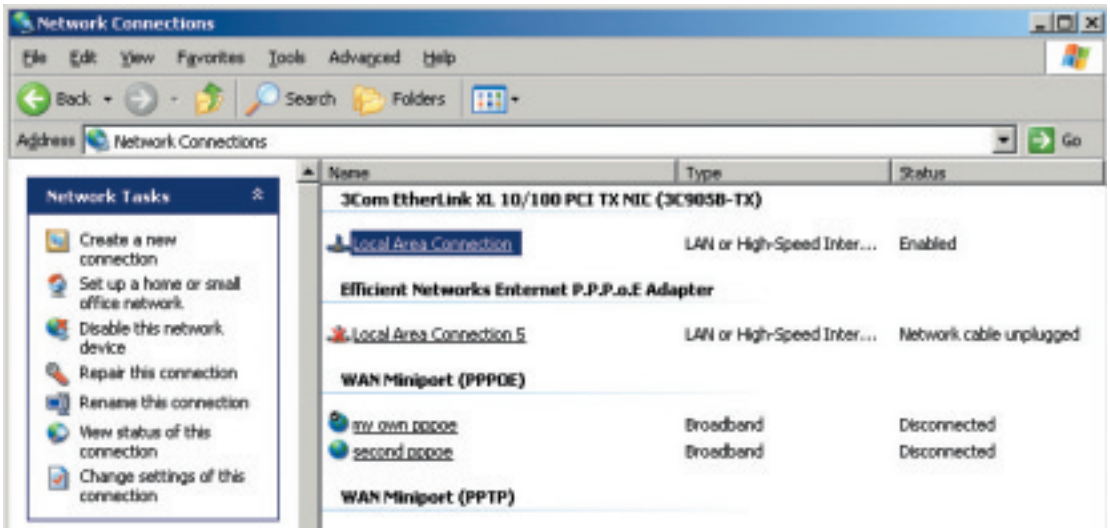
Windows XP

Step 1 On your desktop, click on the **My Network Places** icon (shown below).

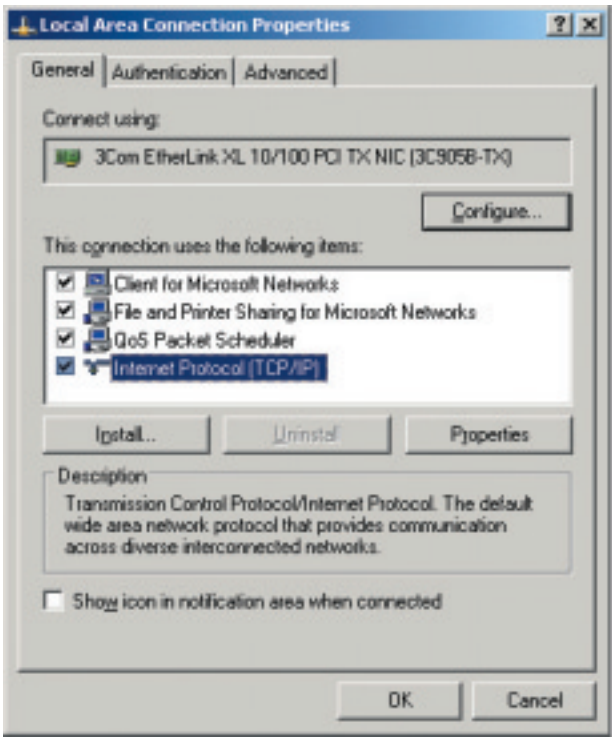
Step 2 The *My Network Places* screen should appear. Under the *Network Tasks* menu, select **View Network Connections**.



Step 3 The *Network Connections* screen should appear. Click the **Local Area Connection** icon.



Step 4 The *Local Area Connection Properties* dialog should appear. From the list of items, select **Internet Protocol (TCP/IP)**.



Step 5 Click **Properties**.

Step 6 Click **OK** buttons to close each dialog.

☞ **NOTE:**

You may need to restart your PC for these changes to take effect.

Task Complete

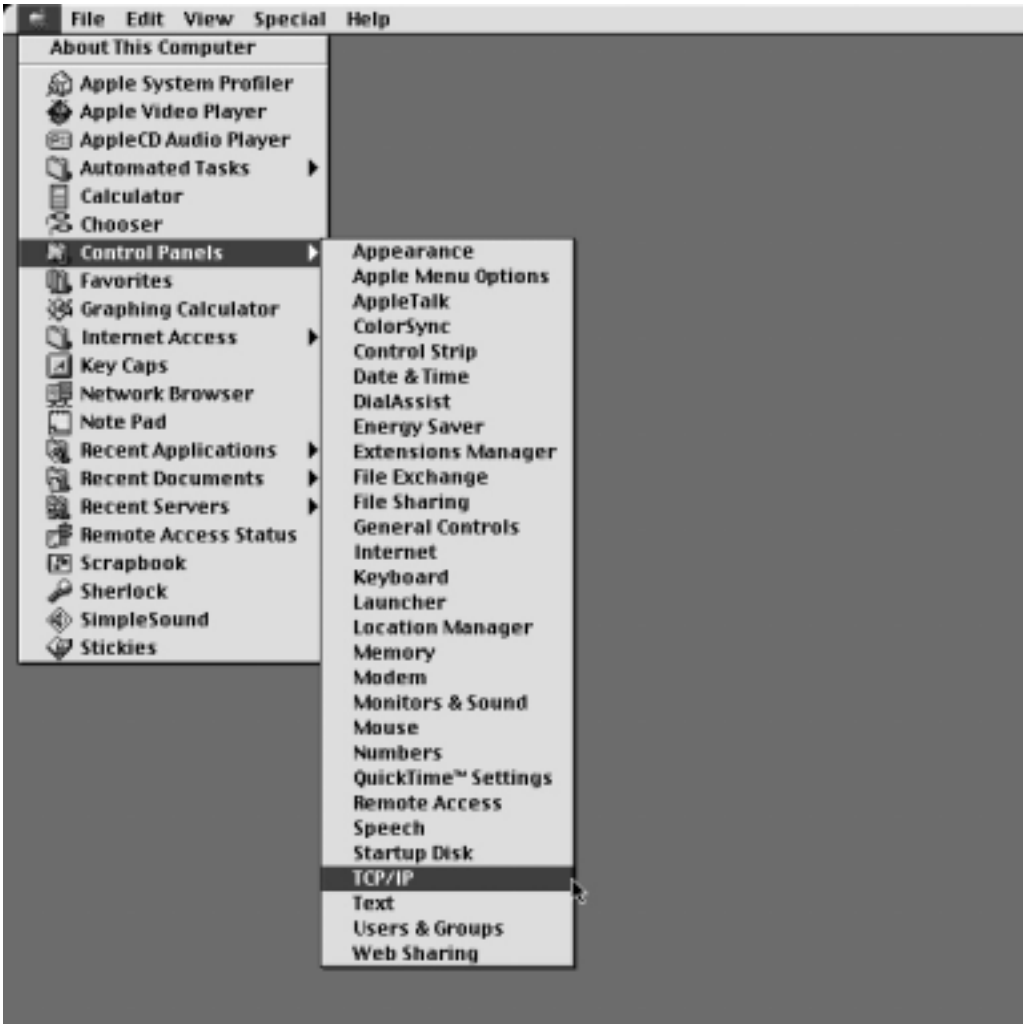
Apple Macintosh

To configure TCP/IP and DHCP on your Macintosh, please select your version of the Mac OS from the following list:

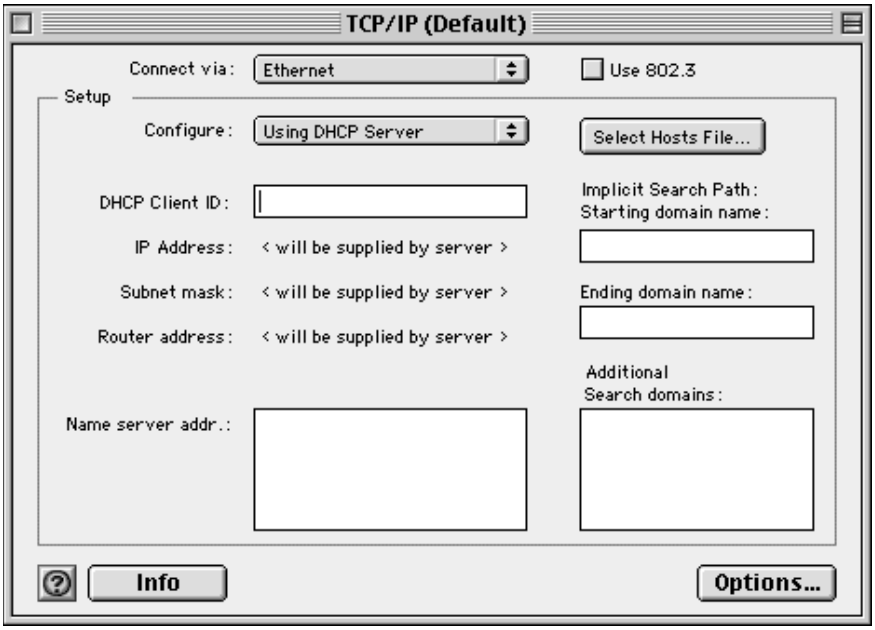
- Mac OS 9.x
- Mac OS X

Mac OS 9.x

Step 1 Under the Apple menu, select **Control Panels** and then **TCP/IP**.



Step 2 The *TCP/IP* control panel should appear. From the *Configure* pull-down menu, select: **Using DHCP Server**.



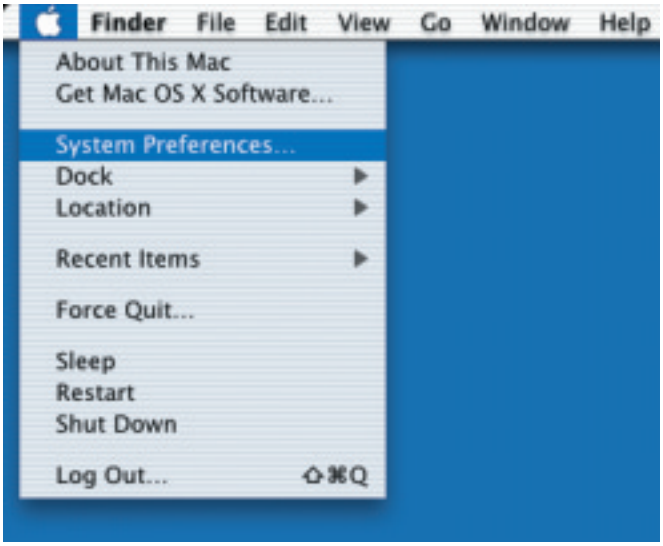
Step 3 Complete the fields shown with any information supplied by your service provider.

Step 4 Click on the **upper left square** in the menu bar to close the *TCP/IP* control panel.

Task Complete

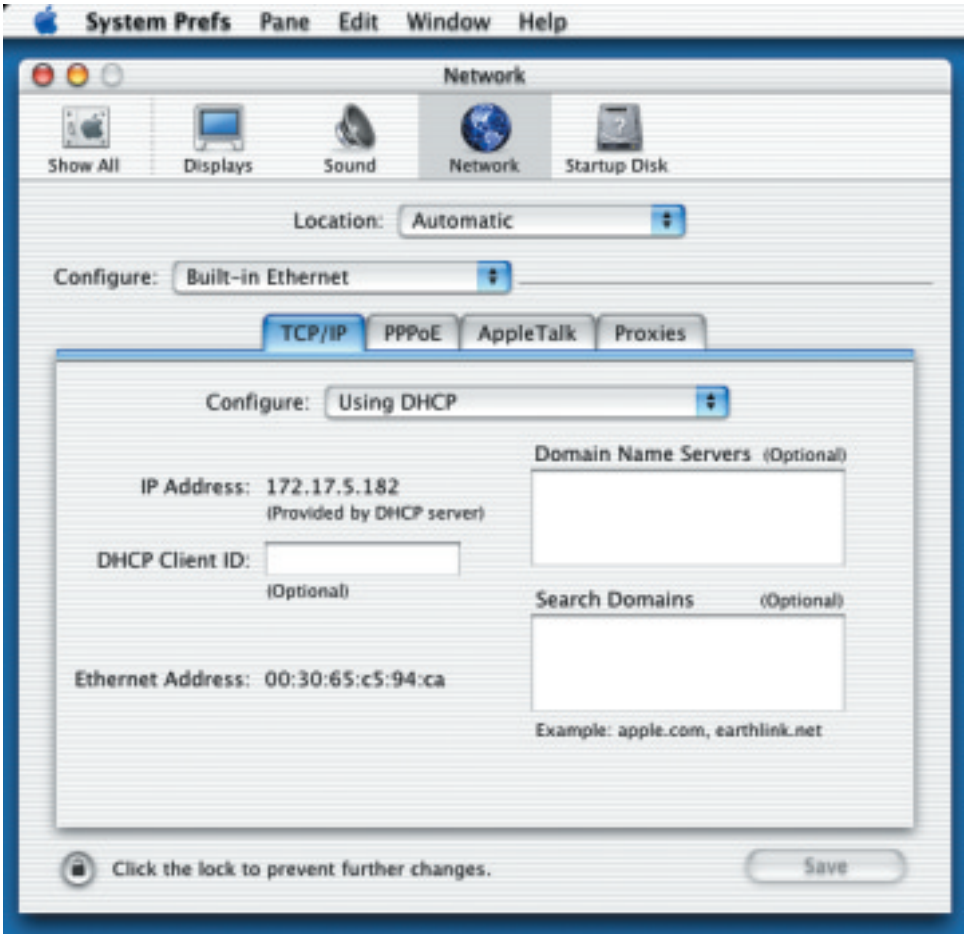
Mac OS X

Step 1 Under the Apple menu, select **System Preferences**.



Step 2 The *System Preferences* window should appear. Click to select the **Network** icon.

Step 3 The *Network* window should appear. Select the **TCP/IP** tab.



Step 4 From the *Configure* pull-down menu, select **Using DHCP**.

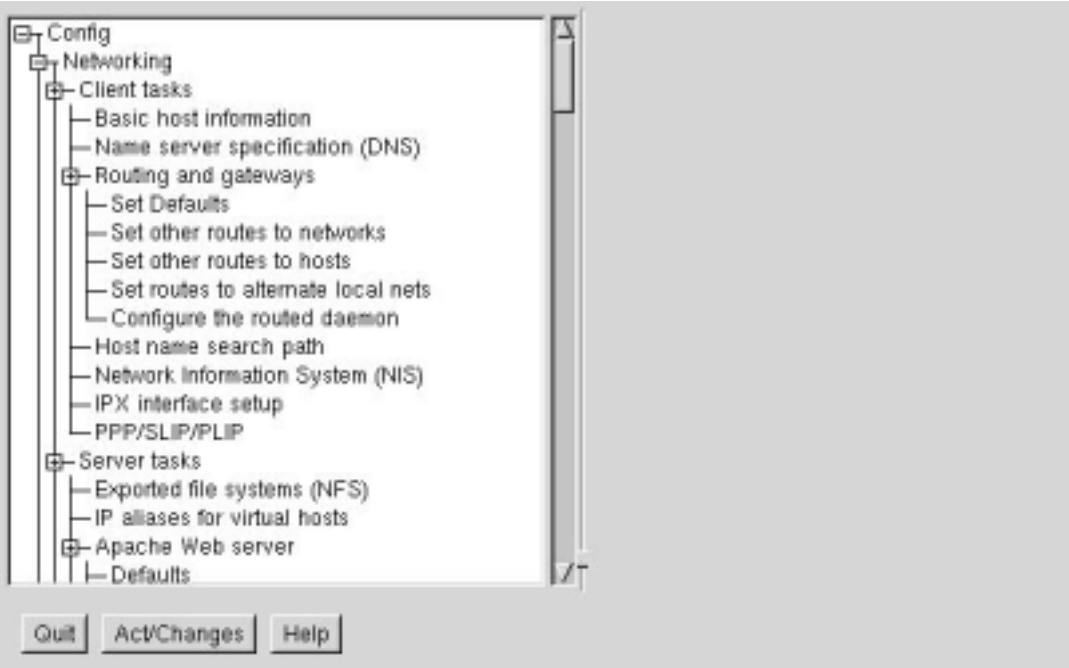
Step 5 Enter any information supplied by your service provider.

Step 6 Click **Save** button to save and exit the *Network* window.

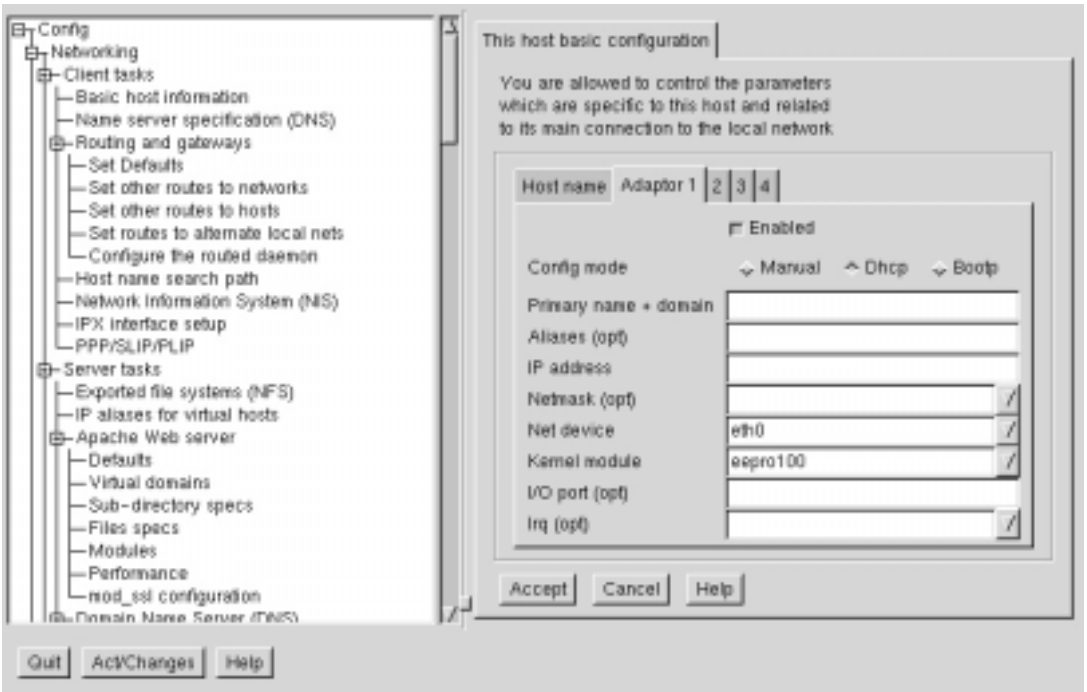
Task Complete

Linux

Step 1 From a terminal window, run **linuxconfig**.

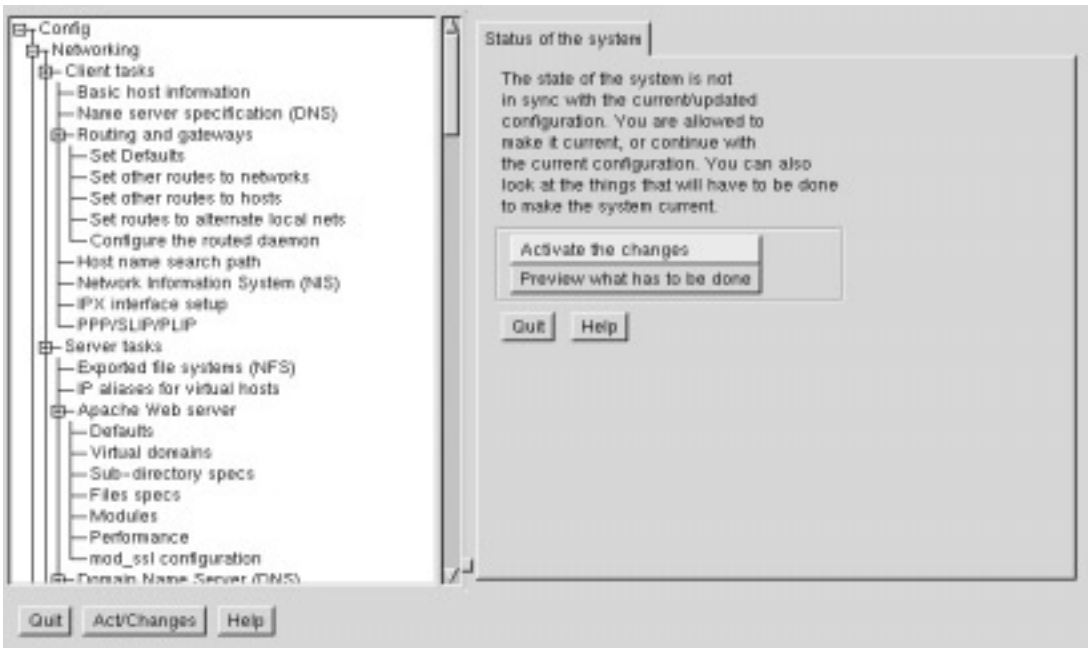


Step 2 The *Config* dialog should appear. Enter any information specified by your service provider in the fields under the appropriate Adapter tab.



Step 3 When settings are completed, Click **Accept**.

Step 4 To update the system status, ensure that the "*Activate the changes*" button is highlighted, then click **Act/Changes**.



Task Complete

Installation

Verify the Package Contents

Your package should contain the items listed below. If you determine anything to be damaged or missing, please contact the dealer from whom the equipment was purchased.

- One Efficient Networks 5900 Series Business gateway
- One Efficient Networks Documentation CD-ROM
- One AC power adapter
- One Ethernet cable, RJ-45
- One ADSL cable, RJ-11, or an additional RJ-45 cable (modem 5950) for SHDSL connection
- One RJ-45 to DB-9 serial port adapter (console)
- One 5900 Series Quick-Start Guide (varies per router model)
- One Safety and Certifications Sheet
- Customer Release Notes with the latest information

Connecting the Router

Step 1 Place your router in a location where it will be well ventilated. Do not stack it with other devices or place it on carpet.

Step 2 Connect your PC directly to any of the routers eight Ethernet ports, using one of the RJ-45 Ethernet cables. You may also connect additional Ethernet devices to the router's Ethernet ports.

Step 3 Connect your router to the DSL jack

- Use the RJ-11 cable (purple label) for models 5930 and 5935
- Use the RJ-45 cable model 5950.

CAUTION:
To reduce the risk of fire, use only no. 26 AWG or larger telecommunications line cord. Such cords are used to connect your DSL port on your router to the DSL (telephone) jack.

Step 4 Optionally, if you will be using the serial interface to perform configuration tasks from the Command Line Interface, connect an Ethernet cable form one of your your PC's serial ports to the MGMT Console port on the rear of the router.

Step 5 Connect the AC power adapter to the Router then to AC power outlet.

Task Complete

Establishing a Connection

To start the configuration, communication must be established with the router. The system can be accessed in the following ways:

- Ethernet connection - via an Ethernet port on the rear of the router.
- Serial - local via the MGMT Console serial port on the rear of the router.

Another consideration in configuring your unit is the type of user interface; there are two user interfaces available on the router:

- Web Management Interface - the Web Management Interface (WMI) is an HTML-based interface that provides easy to use graphical screens for simple configuration of your router. The WMI is not available over the serial port.
- Command-line interface - provides a way to perform custom configurations utilizing the full command set of the system by typing parameters at a command prompt. The command line interface is available through the serial port using terminal emulation software, or remotely through a network node that can reach the unit using the LAN or WAN IP address using TELNET.

Connecting through the Web Management Interface

Step 1 Using your web browser, enter the following default router address into the address field of your browser:
http://192.168.254.254/

Step 2 At the login prompt, make the following entries:
User Name: *superuser*
Password: *admin*

Step 3 After you have logged into your, you will be prompted to change the default password. Enter the new password information as required.

Step 4 When prompted, log-in again with the new user account information.

Task Complete

Accessing the Command Line Interface

To use the Command Line Interface, you must first access the router command line. To do this, perform the following steps:

Step 1 If not previously connected, connect a PC (or ASCII) terminal to a port of the router. (The required cable and adapter are provided with the router. The connection procedure is described in detail in the User Reference Guide that came with the router.)

Step 2 Restart the PC and power on the router.

Step 3 Open a terminal window or start a terminal session on the PC.

Step 4 The router displays the login prompt. Login with the username *superuser*.

```
Username:
```

Step 5 The router displays the password prompt, enter the login password (default password is *admin*.

```
Password:
```

☞ **NOTE:**

The password will be displayed as `*****`

Step 6 A confirmation is returned; the command line interface is now available.

```
Logged in successfully!
```

Step 7 If the default login password (*admin*) was used a message will be displayed.

```
************************************************************

WARNING: You must change your password from the default value!

************************************************************
```

Step 8 Enter a new password at the prompt.

```
Enter New Password:
```

Step 9 Enter a new password at the prompt.

```
Enter New Password Again:
```

The password change will be confirmed:

```
Password changed.
```

The command line is now available for use.

Task Complete

Terminal Sessions

The router supports both local access and remote access. In step 3 above, the terminal session could be:

- Terminal Session under Windows (HyperTerminal) or Terminal Session for Macintosh or UNIX (for local access)
- Telnet Session for Remote Access

Terminal Session under Windows (HyperTerminal)

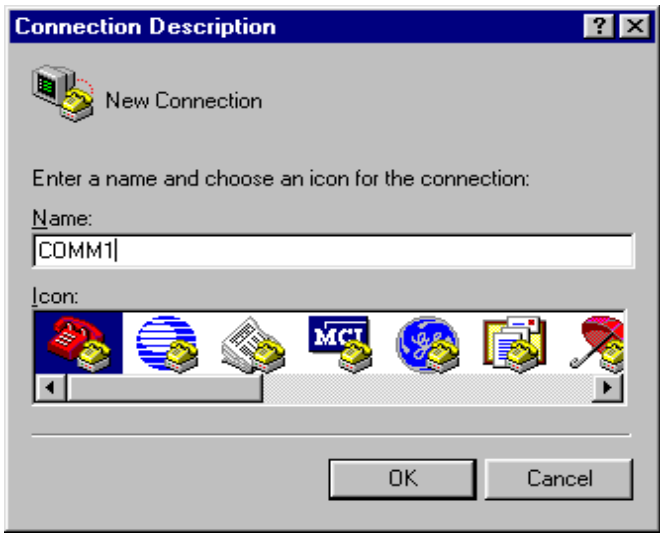
To open the HyperTerminal emulator available under the Windows operating system:

Step 1 Click **Start** on the Windows taskbar, then select:

> Programs
>
> > Accessories
> >
> > > Communications
> > >
> > > > Hyperterminal
> > > >
> > > > > Hyper Terminal

The *HyperTerminal* window will appear in the background and you will be prompted for configuration information.

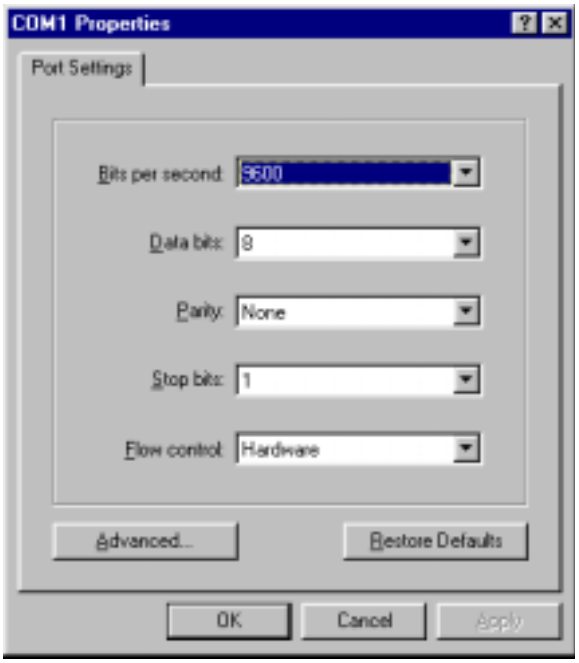
Step 2 In the *Connection Description* window, enter a **name** for the connection and select **OK**.



Step 3 In the *Phone Number* window, under **Connect using**, select **Com 1** (or **2**).

Step 4 In the *Com 1* (or *2*) *Properties* page, enter the following **port settings** and click **OK**:

Bits per second: 9600[a]
Data bits: 8
Parity: None
Stop bits: 1
Flow control: Hardware



[a] To use a baud rate other than 9600, see "Option 7: Set Console Baud Rate" on page 4-39.

Task Complete

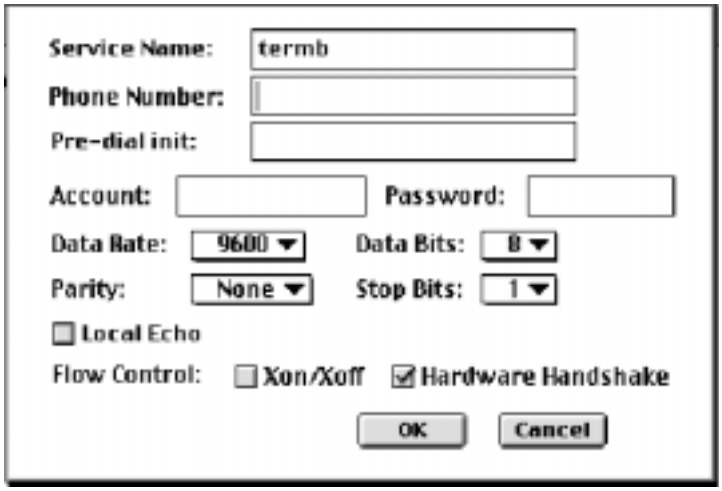
Terminal Session for Macintosh or UNIX

To open a terminal window emulation in a Macintosh or UNIX environment, a VT100 terminal emulation program is required.

Step 1 Start your VT100 terminal emulator.

Step 2 Configure the emulator with the following settings:

Bits per second: 9600[a]
Data bits: 8
Parity: None
Stop bits: 1
Flow control: Hardware



[a] To use a baud rate other than 9600, see "Option 7: Set Console Baud Rate" on page 4-39.

Task Complete

Telnet Session for Remote Access

From the local area network you can use TELNET to login in using the Ethernet IP address.

☞ **NOTE:**

Remote access to the router configuration can be disabled or restricted. For further information, see "Controlling Remote Management" on page 5-15.

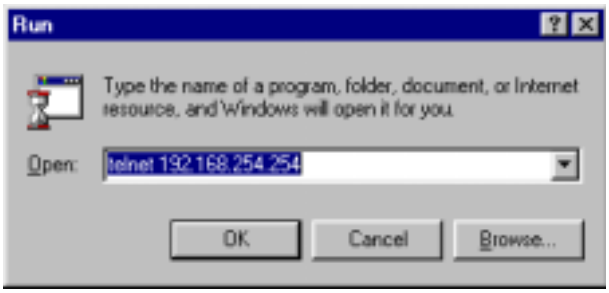
Step 1 Make sure that your PC and router addresses are in the same subnetwork. For example, the router address could be 192.168.254.254 and the PC address could be 192.168.254.253.

Step 2 Start a TELNET session.

a. If you are using a PC running Windows" 95/98/NT", select **Start > Run**. If on a UNIX system, bring up a *shell* window.

b. In the *Run* dialog box (or shell) window, enter:

```
telnet 192.168.254.254
```



c. Click **OK**, or press <Enter>.

Step 3 A TELNET window will be launched; a line identifying the router will be displayed, followed by the **Login:** prompt as shown below.

```
Efficient 5950 G.SHDSL [ATM] Router (5950-001) v6.0.0 Ready
Username:
```

Task Complete

Configuring the Router

Having planned your configuration and acquired the necessary information as described in Planning the Configuration, you are ready to configure your router. If you will be configuring the system though the Web management Interface, please refer to the User Reference Guide located on this CD. The content to follow details the configuration via the command line interface.

This section assumes that you have:

- installed the router hardware,
- connected to the router with a terminal emulation session (or ASCII terminal), and,
- powered the unit on.

This section contains configuration commands for each combination of link protocol and network protocol supported by the router. (Your Network Service Provider determines the link protocol that you use.)

For complete, individual descriptions of the commands mentioned in this section, hyperlinks are provided to the command syntax of the Command Line Interface Guide.

☞ **NOTE:**

If you are setting up both ends of the network, use a mirror image of the information listed below for configuring the router on the other end of the link.

Important: If you change any the of the following settings, you must save the change and then either reboot the router or restart the interface for the change to take effect:

Ethernet LAN: Ethernet IP or IPX address, TCP/IP routing, IPX routing

Bridging: Bridging, filters

Remote Router: TCP/IP route addresses, IPX routes, IPX SAPs and bridging control, and enable, disable, or add remote routers

Configuration Tables

The following tables provide step-by-step instructions for enabling standard configurations of the following network protocol/link protocol combinations via the command line interface. For instruction on protocol/link configuration via the Web Management Interface, see “Easy Setup” on page 8-4.

Table 3-1: Configuration Tables

Link Protocol	Network Protocol	Configuration Table
PPP	IP Routing	Table 3-2, “PPP with IP Routing”
PPP	IPX Routing	Table 3-3, “PPP with IPX Routing”
PPP	Bridging	Table 3-4, “PPP with Bridging”
RFC 1483	IP Routing	Table 3-5, “RFC 1483 / RFC 1490 with IP Routing”
RFC 1490	IP Routing	Table 3-5, “RFC 1483 / RFC 1490 with IP Routing”
RFC 1483	IPX Routing	Table 3-6, “RFC 1483 / RFC 1490 with IPX Routing”
RFC 1490	IPX Routing	Table 3-6, “RFC 1483 / RFC 1490 with IPX Routing”
RFC 1483	Bridging	Table 3-7, “RFC 1483 / RFC 1490 with Bridging”
RFC 1490	Bridging	Table 3-7, “RFC 1483 / RFC 1490 with Bridging”
RFC 1483MER	IP Routing	Table 3-8, “RFC 1483MER / RFCMER 1490 with IP Routing”
RFC 1490MER	IP Routing	Table 3-8, “RFC 1483MER / RFCMER 1490 with IP Routing”

Configuring PPP with IP Routing

This table outlines configuration commands for the PPP link protocol with the IP Routing network protocol.

Table 3-2: PPP with IP Routing

Steps	Settings	Commands
System Settings		
System Name	Required	system name <*name*>
System Message	Optional	system msg <*message*>
Authentication Password	Required	system passwd <*password*>
Ethernet IP Address	As Required	eth ip addr <*ipaddr*> <*ipnetmask*> [<*port#*>]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Change Login	Optional	password <*password*>
Remote Routers		
New Entry	Enter: Remote Name	remote add <*remoteName*>
Link Protocol/PVC[a] (for ATM routers)	Select: PPP Enter: VPI/VCI numbers	remote setprotocol ppp <*remoteName*> remote setpvc<*vpi number*>*<*vci number*> <*re-moteName*>
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: PPP Enter: DLCI num-ber	remote setprotocol ppp <*remoteName*> remote setdlci <*number*> <*remoteName*>
Security [c] Remote's Password	Choose security level Enter: password	remote setauthen <*protocol*> <*remoteName*> remote setourpasswd <*password*> <*remote-Name*>
Bridging On/Off	Must be off	remote disbridge <remoteName>
TCP/IP Route Ad-dress	Enter: Explicit or default route	remote addiproute <*ipnet*> <*ipnetmask*> <*hops*> <*remoteName*>
If NAT is enabled:	To enable NAT, use:	remote setiptranslate on <*remoteName*>
	You may need to enter a Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remote-Name*>

Table 3-2: PPP with IP Routing (Cont.)

Steps	Settings	Commands
If NAT is not enabled:	You may need to enter a Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remote-Name*>
IP and IPX Routing		
TCP/IP Routing (Internet Firewall)	Must be enabled (optional)	eth ip enable eth ip firewall <*on* | *off*>
IPX Routing	Must be disabled	eth ipx disable
Store Reboot		save reboot

[a] Enter this information if you are using PPP in an ATM environment.
[b] Enter this information if you are using PPP in a Frame Relay environment.
[c] If the ISP does not support the authentication of the ISP system by the caller, use the command remote disauthen <remoteName> to disable the authentication.

Configuring PPP with IPX Routing

This table outlines configuration commands for the PPP link protocol with the IPX Routing network protocol.

Table 3-3: PPP with IPX Routing

Steps	Settings	Commands
System Settings		
System Name	Required	system name <*name*>
System Message	Optional	system msg <*message*>
Authentication Password	Required	system passwd <password>
Ethernet IP Address	As Required	eth ip addr <*ipaddr*> <*ipnetmask*> [<*port#*>]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Change Login	Optional	password <*password*>
Ethernet IPX Network #	Enter: IPX network # Frame Type (default: 802.2)	eth ipx addr <*ipxnet*> [<*port#*>] eth ipx frame <*type*>

Table 3-3: PPP with IPX Routing (Cont.)

Steps	Settings	Commands
Remote Routers		
New Entry	Enter: Remote Name	remote add *<remoteName>*
Link Protocol/PVC[a] (for ATM routers)	Select: PPP Enter: VPI/VCI numbers	remote setprotocol ppp *<remoteName>* remote setpvc *<vpi number>*<vci number> <remoteName>*
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: PPP Enter: DLCI number	remote setprotocol ppp *<remoteName>* remote setdlci *<number> <remoteName>*
Security [c] Remote's Password	Choose security level Enter: password	remote setauthen *<protocol> <remoteName>* remote setourpasswd *<password> <remoteName>*
Bridging On/Off	Must be off	remote disbridge *<remoteName>*
Add IPX Routes	Enter appropriate info	remote addipxroute *<ipxNet> <metric> <ticks> <remoteName>*
Add IPX SAPs	Enter appropriate info	remote setipxaddr *<ipxNet> <remoteName>*
WAN Network #	Enter appropriate info	remote setipxaddr *<ipxNet> <remoteName>*
IP and IPX Routing		
TCP/IP Routing	Must be disabled	eth ip disable
IPX Routing	Must be enabled	eth ipx enable
Store Reboot		save reboot

[a] Enter this information if you are using PPP in an ATM environment.
[b] Enter this information if you are using PPP in a Frame Relay environment.
[c] If the ISP does not support the authentication of the ISP system by the caller, use the command remote disauthen <remoteName> to disable the authentication.

Configuring PPP with Bridging

This table outlines configuration commands for the PPP link protocol with the Bridging network protocol.

Table 3-4: PPP with Bridging

Steps	Settings	Commands
System Settings		
System Name	Required	system name <*name*>
System Message	Optional	system msg <*message*>
Authentication Password	Required	system passwd <*password*>
Ethernet IP Address	As Required	eth ip addr <*ipaddr*> <*ipnetmask*> [<*port#*>]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Change Login	Optional	password <*password*>
Remote Routers		
New Entry	Enter: Remote Name	remote add <*remoteName*>
Link Protocol/PVC[a] (for ATM routers)	Select: PPP Enter: VPI/VCI numbers	remote setprotocol ppp <*remotename*> remote setpvc <*vpi number*>*<*vci number*> <*re-moteName*>
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: PPP Enter: DLCI num-ber	remote setprotocol ppp <*remotename*> remote setdlci <*number*> <*remoteName*>
Security [c] Remote's Password	Choose security level Enter: password	remote setauthen <*protocol*> <*remoteName*> remote setourpasswd <*password*> <*remote-Name*>
Bridging On/Off	Must be on	remote enabridge <*remoteName*>
TCP/IP Route Ad-dress	Enter: Explicit or default route	remote addiproute <*ipnet*> <*ipnetmask*> <*hops*> <*remoteName*>
If NAT is enabled:	To enable NAT, use:	remote setiptranslate on <*remoteName*>
	You may need to enter a Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remote-name*>

Table 3-4: PPP with Bridging (Cont.)

Steps	Settings	Commands
If NAT is not enabled:	You may need to enter a Source WAN Port Address	remote setsrcipaddr *<ipaddr> <mask> <remoteName>*
IP and IPX Routing		
TCP/IP Routing	Must be disabled	eth ip disable
IPX Routing	Must be disabled	eth ipx disable
Store Reboot		save reboot

[a] Enter this information if you are using PPP in an ATM environment.
[b] Enter this information if you are using PPP in a Frame Relay environment.
[c] If the ISP does not support the authentication of the ISP system by the caller, use the command remote disauthen <remoteName> to disable the authentication.

Configuring RFC 1483 / RFC 1490 with IP Routing

This table outlines configuration commands for the RFC 1483 and the RFC 1490 link protocols with the IP Routing network protocol.

Table 3-5: RFC 1483 / RFC 1490 with IP Routing

Steps	Settings	Commands
System Settings		
System Message	Optional	system msg *<message>*
Ethernet IP Address	As Required	eth ip addr *<ipaddr> <ipnetmask>* [*<port#>*]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname *<domainname>* dhcp set valueoption domainnameserver *<ipaddr>*
Change Login	Optional	password *<password>*
Remote Routers		
New Entry	Enter: Remote Name	remote add *<remoteName>*
Link Protocol/PVC[a] (for ATM routers)	Select: PPP Enter: VPI/VCI numbers	remote setprotocol ppp *<remotename>* remote setpvc *<vpi number>*<vci number> <remoteName>*

Table 3-5: RFC 1483 / RFC 1490 with IP Routing (Cont.)

Steps	Settings	Commands
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: PPP Enter: DLCI number	remote setprotocol ppp <*remotename*> remote setdlci <*number*> <*remoteName*>
Bridging On/Off	Must be off	remote disbridge <*remoteName*>
TCP/IP Route Address	Enter: Explicit or default route	remote addiproute <*ipnet*> <*ipnetmask*> <*hops*> <*remoteName*>
If NAT is enabled:	To enable NAT, use:	remote setiptranslate on <*remoteName*>
TCP/IP Route Addresses	Enter: Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remoteName*>
If NAT is not enabled:	You may still need to enter a Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remoteName*>
IP and IPX Routing		
TCP/IP Routing (Internet Firewall)	Must be enabled (optional)	eth ip enable eth ip firewall <*on* | *off*>
IPX Routing	Must be disabled	eth ipx disable
Store Reboot		save reboot

[a] Enter this information if you are using RFC 1483 in an ATM environment.
[b] Enter this information if you are using RFC 1490 in a Frame Relay environment.

Configuring RFC 1483 / RFC 1490 with IPX Routing

This table outlines configuration commands for the RFC 1483 and RFC 1490 link protocols with the IPX Routing network protocol.

Table 3-6: RFC 1483 / RFC 1490 with IPX Routing

Steps	Settings	Commands
System Settings		
System Message	Optional	system msg <*message*>
Ethernet IP Address	As Required	eth ip addr <*ipaddr*> <*ipnetmask*> [<*port#*>]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Ethernet IPX Network #	Enter: IPX Network # Frame Type (default is 802.2)	eth ipx frame <*type*>
Change Login	Optional	password <*password*>
Remote Routers		
New Entry	Enter: Remote Name	remote add <*remoteName*>
Link Protocol/PVC[a] (for ATM routers)	Select: RFC 1483 Enter: VPI/VCI numbers	remote setprotocol rfc1483 <*remotename*> remote setpvc <*vpi number*>*<*vci number*> <*remoteName*>
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: FR Enter: DLCI number	remote setprotocol fr <*remotename*> remote setdlci <*number*> <*remotename*>
Bridging On/Off	Must be off	remote disbridge <*remoteName*>
IPX Routes Add	Enter appropriate info	remote addipxroute <*ipxNet*> <*metric*> <*ticks*> <*remoteName*>
IPX SAPs Add	Enter appropriate info	remote addipxsap <*servicename*> <*ipxNet*> < *ipxNode*> <*socket*> <*type*> <*hops*> <*remote-Name*>
WAN Network Number	Enter appropriate info	remote setipxaddr <*ipxNet*> <*remoteName*>
IP and IPX Routing		
TCP/IP Routing (Internet Firewall)	Must be disabled (optional)	eth ip enable eth ip firewall <*on* | *off*>

Table 3-6: RFC 1483 / RFC 1490 with IPX Routing (Cont.)

Steps	Settings	Commands
IPX Routing	Must be enabled	eth ipx enable
Store Reboot		save reboot

[a] Enter this information if you are using RFC 1483 in an ATM environment.
[b] Enter this information if you are using RFC 1490 in a Frame Relay environment.

Configuring RFC 1483 / RFC 1490 with Bridging

This table outlines configuration commands for the RFC 1483 and RFC 1490 link protocols with the Bridging network protocol.

Table 3-7: RFC 1483 / RFC 1490 with Bridging

Steps	Settings	Commands
System Settings		
System Message	Optional	system msg <*message*>
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Change Login	Optional	password <*password*>
Remote Routers		
New Entry	Enter: Remote Name	remote add <*remoteName*>
Link Protocol/PVC[a] (for ATM routers)	Select: RFC1483 Enter: VPI/VCI numbers	remote setprotocol rfc1483 <*remotename*> remote setpvc <*vpi number*>*<*vci number*> <*re-moteName*>
Link Protocol/DLCI[b] (for Frame Relay routers)	Select: FR Enter: DLCI num-ber	remote setprotocol fr <*remotename*> remote setdlci <*number*> <*remoteName*>
Bridging On/Off	Must be on	remote enabridge <*remoteName*>
If NAT is not en-abled:	You may need to enter a Source WAN Port Address	remote setsrcipaddr <*ipaddr*> <*mask*> <*remote-Name*>
IP and IPX Routing		
IP Routing	Must be disabled	eth ip disable

Table 3-7: RFC 1483 / RFC 1490 with Bridging (Cont.)

Steps	Settings	Commands
IPX Routing	Must be disabled	eth ipx disable
Store Reboot		save reboot

[a] Enter this information if you are using RFC 1483 in an ATM environment.
[b] Enter this information if you are using RFC 1490 in a Frame Relay environment.

Configuring RFC 1483MER / RFC 1490MER with IP Routing

This table outlines configuration commands for the RFC 1483MER and RFC 1490MER link protocols with the IP Routing network protocol.

Table 3-8: RFC 1483MER / RFCMER 1490 with IP Routing

Steps	Settings	Commands
System Settings		
System Message	Optional	system msg <*message*>
Ethernet IP Address	As Required	eth ip addr <*ipaddr*> <*ipnetmask*> [<*port#*>]
DHCP Settings	Already enabled; additional settings may be required	dhcp set valueoption domainname <*domain-name*> dhcp set valueoption domainnameserver <*ipad-dr*>
Change Login	Optional	password <*password*>
Remote Routers		
New Entry	Enter: Remote Name	remote add <*remoteName*>
Link Protocol/PVC[a] (for ATM routers)	Select: RFC 1483MER Enter: VPI/VCI num-bers	remote setprotocol rfc1mer <*remotename*> remote setpvc <*vpi number*>*<*vci number*> <*re-moteName*>
Link Protocol/DLCI[b] (for Frame Relay rout-ers)	Select: MER Enter: DLCI number	remote setprotocol mer <*remotename*> remote setdlci <*number*> <*remoteName*>
Bridging On/Off	Must be off	remote disbridge <*remoteName*>
If NAT is enabled:	To enable NAT, use:	remote setiptranslate on <*remoteName*>

Table 3-8: RFC 1483MER / RFCMER 1490 with IP Routing (Cont.)

Steps	Settings	Commands
If NAT is not enabled:	Enter: Source WAN Port Address + mask of the remote network	remote setsrcipaddr *<ipaddr> <mask> <remote-Name>*
TCP/IP Route Addresses	Enter: Source WAN Port Address + mask of the remote network's mask	remote setsrcipaddr *<ipaddr> <mask> <remote-Name>*
IP and IPX Routing		
TCP/IP Routing (Internet Firewall)	Must be disabled (optional)	eth ip enable eth ip firewall *<on | off>*
IPX Routing	Must be disabled	eth ipx disable
Store Reboot		save reboot

[a] Enter this information if you are using RFC 1483 in an ATM environment.
[b] Enter this information if you are using RFC 1490 in a Frame Relay environment.

Verify the Router Configuration

This section contains procedures to verify the router configuration testing IP, IPX and bridging.

Test IP Routing

Test IP Routing over the Local Ethernet LAN (from PC)

- Use the TCP/IP **ping** command or a similar method to contact the configured local router specifying the Ethernet LAN IP address. The LEDs on the router should flash for each ping received.
- If you cannot contact the router, verify that the Ethernet IP address and subnet mask are correct and check the cable connections.
- Make sure that you have saved and rebooted after setting the IP address.
- Check Network TCP/IP properties under Windows 95. If you are running Windows 3.1, check that you have a TCP/IP driver installed.

Test IP Routing to a Remote Destination

- Using the TCP/IP ping command, contact a remote router from a local LAN-connected PC. When you enter the ping command, the router will connect to the remote router using the DSL line.
- If remote or local WAN IP addresses are required, verify that they are valid.
- Use the iproutes command to check, first, the contents of the IP routing table and, second, that you have specified a default route as well.

Test Routing from a Remote Destination

Have a remote router contact the local router using a similar method.

Test TCP/IP Routes

- Contact a station, subnetwork, or host located on the network beyond a remote router to verify the TCP/IP route addresses entered in the remote router database.
- Verify that you configured the correct static IP routes.
- Use the iproutes command to check the contents of the IP routing table.

Test Bridging to a Remote Destination

Use any application from a local LAN-attached station that accesses a server or disk using a protocol that is being bridged on the remote network beyond the remote router. If you cannot access the server:

- Verify that you have specified a default destination remote router.
- Make sure that you have enabled bridging to the remote router.
- Check that bridge filtering does not restrict access from the local station.

Test IPX Routing

One way to test IPX routing is to check for access to servers on the remote LAN. Under Windows, use the NetWare Connections selection provided with NetWare User Tools. Under DOS, use the command pconsole or type login on the login drive (usually F:). Select the printer server and verify that the server you have defined is listed. When you attempt to access the server, the router will connect to the remote router using the DSL line.

If you cannot access the remote server:

- Check that the local Ethernet LAN IPX network number is correct.
- Verify that the WAN link network number is the same as the remote WAN link network number.
- Check cable connections and pinouts.
- Verify that the IPX routes and IPX SAPs you have specified are correct.
- List the contents of the routing and services tables using the ipxroutes and ipxsaps commands, respectively.
- Make sure that the security authentication method and password that you configured match the remote router.

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CHAPTER 4

SYSTEM MANAGEMENT

This chapter provides information on a variety of system features and procedures. These features include:

- DHCP (Dynamic Host Configuration Protocol)
- BootP Service
- Network Address Translation (NAT)
- Key Enabled Features
- Spanning Tree
- Boot Code Options
- Software Kernel Upgrades
- Quality of Service (QOS)
- Misc. Administrative Functions

The router has several other features that are discussed in other section of this document. A list supplying links to some of these features is provided below.

- “IP Filtering” on page 5-23
- “L2TP Tunneling - Virtual Dial-Up” on page 6-26
- “PAP/CHAP Security Authentication” on page 5-20
- “Radius” on page 5-10
- “SNMP” on page 7-2
- “SSH” on page 5-70
- “Stateful Firewall” on page 5-34
- “User Authentication” on page 5-2
- “VPN” on page 6-46
- “WEB Management Interface” on page 8-1

DHCP (Dynamic Host Configuration Protocol)

The router supports DHCP and can act as the DHCP server. (The router's DHCP server disables itself if it locates other active DHCP servers on the network or if a DHCP server on the WAN has been explicitly specified.)

When configured, the router can provide DHCP functions as follows:

- As a server, IP addresses are assigned to workstations attached to the LAN that issue DHCP address requests.
- As a client, the router requests that an IP address be assigned to the WAN side port of the router.
- As a relay, the router passes through client requests from the LAN side onto the WAN asking for IP address assignment and relays responses back to the appropriate client.

This section describes how to configure DHCP. The procedures that follow illustrate the process using the Command Line Interface; to configure DHCP via the WMI, use the DCHP Configuration page (page 8-35). Configuring DHCP can be a complex process; this section is therefore intended for network managers. For a complete list and explanation of the DHCP commands, refer to the Command Line Interface Guide: Chapter 8, DHCP Commands.

☞ **NOTE:**

Some DHCP values can be set using the Windows Quick Start application, the Windows Configuration Manager, or the web-based EZ Setup application.

DHCP Address Allocation

DHCP is a service that allocates IP addresses *automatically* to any DHCP client requesting an IP address. (A DHCP client can be any device attached to your network, for example, a PC.) It can also provide option values (such as the subnet mask, DNS, and gateway values) automatically.

Using DHCP to automatically acquire initialization parameters translates into avoiding the more involved router/PC manual initialization process. (The manual initialization requires re-configuration of router and/or PC addresses to be in the same network.)

To configure DHCP for a network, the network administrator defines a range of valid IP addresses to be used in the subnetwork as well as options and other parameters. This process is described in the next section, DHCP Administration and Configuration.

☞ **NOTE:**

DHCP is effective only if the TCP/IP stack is installed on the PCs.

☞ **NOTE:**

For information on configuring the PC for DHCP, see “Configuring Your Computer” on page 3-14.

DHCP Client Requests

Before becoming active, the router’s DHCP server attempts to locate other active DHCP servers on the network, such as Windows NT servers. If one is detected, the router’s DHCP server disables itself.

When the WAN link activates and the source IP address or mask is undefined (i.e. 0.0.0.0), the router places a DHCP client request over the WAN link. The router may learn the following parameters:

- DNS address
- Default gateway
- Syslog server IP address
- Time server IP address
- Source IP address to use

To see the gateway and source IP addresses that were returned, use the iproutes command.

The IP addresses and options assigned to a client are collectively called the “lease”. The lease is only valid for a certain period of time and is automatically renewed by the client.

DHCP Administration and Configuration

The DHCP administration and configuration process is divided into the following functions:

- Manipulating Subnetworks and Explicit Client Leases
- Setting Option Values
- Managing BootP
- Configuring BootP/DHCP Relays
- Defining Option Types
- Other information

The configuration procedures that follow are based on entering the commands through the Command Line Interface, for configuration via the Web Management interface, see “DCHP Configuration” on page 8-35.

Manipulating Subnetworks and Explicit Client Leases

Enabling/Disabling a Subnetwork or a Client Lease

To enable/disable a subnetwork or a client lease, use the commands:

```
-> dhcp enable all | <net> <ipaddr>
-> dhcp disable all| <net> <ipaddr>
```

Examples

To enable the subnetwork 192.168.254.0 if that subnetwork exists, enter:

```
-> dhcp enable 192.168.254.0
```

To enable the client lease 192.168.254.17 if that client lease exists, enter:

```
-> dhcp enable 192.168.254.17
```

To disable the client lease 192.168.254.18 if that client lease exists, enter:

```
-> dhcp disable 192.168.254.18
```

To check the results of these commands, use:

```
-> dhcp list
```

If the client lease does not exist, it must be explicitly created.

Adding a Subnetwork

The following commands are used to add/delete subnetworks. Only one subnetwork with one pool of IP addresses may be defined for a subnet.

To add a subnetwork, use:

```
-> dhcp add <net> <mask>
```

To remove a subnetwork, use:

```
-> dhcp del <net>
```

☞ **NOTE:**
All client leases associated with this subnetwork are automatically deleted.

Example 1:

The following command creates a subnetwork 192.168.254.0 with a subnet mask of 255.255.255.0:

```
-> dhcp add 192.168.254.0 255.255.255.0
```

Example 2:

The following command deletes the subnetwork 192.168.254.0 and deletes all client leases associated with that subnetwork:

```
-> dhcp del 192.168.254.0
```

Adding Explicit or Dynamic Client Leases

Client leases may either be created dynamically or explicitly. Usually client leases are created dynamically when PCs boot and ask for IP addresses.

Explicit client leases

To add an explicit client lease, a subnetwork must already exist. Use the following command before adding the client lease:

-> dhcp add *<net> <mask>*

Once the lease has been added, use the following command to assign the lease to the client:

-> dhcp add *<ipaddr>*

To remove a client lease, use:

-> dhcp del *<ipaddr>*

☞ **NOTE:**
An administrator may create a client lease that is part of a subnet but does not fall within the pool of IP addresses.

Example 1:

To explicitly add the client lease 192.168.254.31, enter:

```
->  dhcp add 192.168.254.31
```

Example 2:

To delete the client lease 192.168.254.31, enter:

```
->  dhcp del 192.168.254.31
```

Dynamic Client Leases

Dynamic client leases are created from the pool of IP addresses associated with that subnetwork.

To set or change the pool, use:

```
-> dhcp set addresses <first ip addr> <last ip addr>
```

To clear the values from the pool, use:

```
-> dhcp clear addresses <net>
```

NOTE:

Any client leases that currently exist will not be affected.

To remove a client lease that was dynamically created, use:

```
-> dhcp del <ipaddr>
```

CAUTION:

If the <*ipaddr*> parameter is a subnet, you will delete the entire subnet.

Setting the Lease Time

The information given by the DHCP server (router) to your PC is leased for a specific amount of time. The client lease has already been selected. The DHCP server will select the lease time based on the option defined for the client lease as described by this algorithm:

1. If the client lease option is a specific number or is infinite, then the server uses the specified lease time associated with this client lease.
2. If the client lease option is “default”, then the server goes up one level (to the subnetwork) and uses the lease time explicitly specified for the subnetwork.
3. If the client and subnetwork lease options are both “default”, then the server goes up one level (global) and uses the lease time defined at the global level (server).
4. Lease time:
   The minimum lease time is 1 hour.
   The global default is 168 hours.

Commands

The following commands are used by network administrators to control lease time.

To set the lease time explicitly for the client lease, use:

```
-> dhcp set lease <ipaddr> <hours>
```

To set the lease time explicitly for the subnetwork lease, use:

```
-> dhcp set lease <net> <hours>
```

To set the lease time explicitly for the global lease, use:

```
-> dhcp list lease <hours>
```

Example 1:

To set the lease time to “default” for the client 192.168.254.17, enter:

```
-> dhcp set lease 192.168.254.17 default
```

Example 2:

To set the subnetwork lease time to infinite for the subnet 192.168.254.0, enter:

```
-> dhcp set lease 192.168.254.0 infinite
```

Example 3:

To set the global lease time to 2 hours, enter:

```
-> dhcp set lease 2
```

Manually Changing Client Leases

In general, administrators do not need to change client leases manually. However, if the need arises to do so, the following two commands are used.

CAUTION:
The client will not be aware that the administrator has changed or released a client lease!

To change the client lease expiration time to a given value, use the following command:

```
-> dhcp set expire <ipaddr> <hours>
```

Setting the expiration time to “*default*” will cause the server to compute the lease time using the algorithm as described in “Setting the Lease Time” on page 4-6.

To release the client lease so it becomes available for other assignments, enter:

```
-> dhcp clear expire <ipaddr>
```

Setting Option Values

Administrators can set values for global options, for options specific to a subnetwork, or for options specific to a client lease.

☞ **NOTE:**
See RFC 2131/2132 for the description of various options.

The DHCP server returns values for options explicitly requested in the client request. It selects the values to return based on the following algorithm:

1. If the value is defined for the client, then the server returns the requested value for an option.
2. If the value for the option has not been set for the client, then the server returns the value option if it has been defined for the subnetwork.
3. If the value option does not exist for the client and does not exist for the subnetwork, then the server returns the value option if it has been defined globally.
4. If the value option is not defined anywhere, the server does not return any value for that option in its reply to the client request.

Important: When the server replies to a client:

- It does not return any option values not requested by the client.
- It does not support the definition of a “class” of clients.
- It does not return any non-default option values unless the client requests the option value and the server has a value defined for that option.
- It does not return any non-default values on the clients subnet unless the client requests the value for that option.

Commands for Global Option Values

To set the value for a global option, enter:

```
-> dhcp set valueoption <code> <value>
```

The code can be a number between *1* and *61* or a <*keyword*>.

To see the list of predefined and user-defined options, enter:

```
-> dhcp list definedoptions
```

To clear the value for a global option, use:

```
-> dhcp clear valueoption <code>
```

Example:

To set the global value for the domain name server option, enter:

```
-> dhcp set valueoption domainnameserver 192.168.254.2
192.168.254.3
```

Commands for Specific Option Values for a Subnetwork

To set the value for an option associated with a subnetwork, enter:

```
-> dhcp set valueoption <net> <code> <value>
```

To clear the value for an option associated with a subnetwork, enter:

```
-> dhcp clear valueoption <net> <code>
```

Examples:

```
-> dhcp set valueoption 192.168.254.0 gateway 192.168.254.254
```

```
-> dhcp set valueoption 6 192.84.210.75 192.84.210.68
```

Commands for Specific Option Values for a Client Lease

To set the value for an option associated with a specific client, enter:

```
-> dhcp set valueoption <ipaddr> <code> <value>
```

To clear the value for an option associated with a specific client, enter:

```
-> dhcp clear valueoption <ipaddr> <code>
```

Example:

```
-> dhcp set valueoption 192.168.254.251 winserver 192.168.254.7
```

Commands for Listing and Checking Option Values

To list the values for global options as well as subnet and client lease information, enter:

```
-> dhcp list
```

To list options that are set for that subnet/client lease as well as subnet/client lease information, enter:

```
-> dhcp list <net> | <code>
```

This command lists all available options (predefined and user-defined options):

```
-> dhcp list definedoptions
```

This command lists all available options starting with the string "*name*".

```
-> dhcp list definedoptions <name>
```

To list the lease time, enter:

```
-> dhcp list lease
```

Example:

This command lists the subnet 192.168.254.0 including any options set specifically for that subnet:

```
-> dhcp list 192.168.254.0
```

Managing BootP

Administrators can enable and disable BootP and specify the BootP server. BootP can be enabled at the subnetwork and at the client lease level.

☞ **NOTE:**
By default, the DHCP server does *not* satisfy BootP requests unless the administrator has explicitly enabled BootP (at the subnetwork or lease level).

About BootP and DHCP

BootP and DHCP provide services that are very similar. However, as an older service, BootP offers only a subset of the services provided by DHCP.

The main difference between BootP and DHCP is that the client lease expiration for a BootP client is always infinite.

☞ **NOTE:**
Remember, when BootP is enabled, the client assumes that the lease is *infinite*.

Enable/Disable BootP

To allow BootP request processing for a particular client/subnet, use the command:

```
-> dhcp bootp allow <net> | <ipaddr>
```

To disallow BootP request processing for a particular client/subnet, enter:

```
-> dhcp bootp disallow <net> | <ipaddr>
```

Specify the Boot (TFTP) Server

The following commands let the administrator specify the TFTP server (boot server) and boot file name. The administrator should first configure the IP address of the TFTP server and file name (kernel) from which to boot.

To set the IP address of the server and the file to boot from, use the following commands:

```
-> dhcp bootp tftpserver <net> | <ipaddr> | <tftpserver ipaddr>
```

```
-> dhcp bootp file [<net> | <ipaddr>] | <filename>
```

To clear the IP address of the server and the file to boot from, enter:

```
-> dhcp bootp tftpserver [<net> | <ipaddr>] 0.0.0.0
```

Example 1:

To set the global BootP server IP address to 192.168.254.7:

```
-> dhcp bootp tftpserver 192.168.254.7
```

Example 2:

To set the subnet 192.168.254.0 server IP address to 192.168.254.8:

```
-> dhcp bootp tftpserver 192.168.254.0 192.168.254.8
```

Example 3:

To set the client 192.168.254.21 server IP address to 192.168.254.9, enter:

```
-> dhcp bootp tftpserver 192.168.254.21 192.168.254.9
```

Example 4:

To set the subnet 192.168.254.0 boot file to "*kernel.100*":

```
-> dhcp bootp file 192.168.254.0 kernel.100
```

Example 5:

To clear the global BootP server IP address and file name:

```
-> dhcp bootp tftpserver 0.0.0.0
```

Example 6:

To clear the subnet 192.168.254.0 server IP address and file name:

```
-> dhcp bootp tftpserver 192.168.254.0 0.0.0.0
```

Configuring BootP/DHCP Relays

BootP/DHCP relays are used by system administrators when the DHCP configuration parameters are acquired from a BootP/DHCP server other than the router's DHCP server.

This function allows configuration information to be centrally controlled. Enabling a BootP/DHCP relay disables DHCP on the router because, by definition, only one policy mechanism can be supported.

However, multiple relays may be specified. BootP/DHCP requests are forwarded to every relay on the list. It is assumed, in this case, that the multiple servers are configured to recognize the requests that they are to handle.

To add a BootP/DHCP Relay address to the list, use the command:

```
-> dhcp addrelay <ipaddr>
```

To remove a BootP/DHCP Relay address from the list, use the command:

```
-> dhcp delrelay <ipaddr>
```

Defining Option Types

A DHCP option is a code, length, or value. An option also has a "*type*" (byte, word, long, longint, binary, IP address, string).

The subnet mask, router gateway, domain name, domain name servers, NetBios name servers are all DHCP options. Refer to RFC 1533 if you require more information.

Users will normally not need to define their own option types. The list of predefined option types based on RFC 1533 can be shown by using the dhcp list definedoptions command.

Commands

The following commands are available for adding/deleting option types:

```
-> dhcp add <code> <min> <max> <type>
```

To list option types that are currently defined, enter:

```
-> dhcp list definedoptions...
```

To list the definitions for all known options, enter:

```
-> dhcp list definedoptions
```

To list the definition for option *1*, if option *1* is defined, type:

```
-> dhcp list definedoptions 1
```

To list the definition for all options that are well-known AND have a name starting with "*h*", type:

```
-> dhcp list definedoptions h
```

Example:

To define a new option with a code of 128, a minimum number of IP addresses of 1, a maximum number of IP addresses of 4, of type "IP address", enter:

```
-> dhcp add 128 1 4 ipaddress
```

This information implies that:

- Some DHCP client will know about the option with code 128.
- Option 128 allows IP addresses.
- The server can have a minimum of 1 IP address.
- The server can have up to 4 IP addresses.
- The administrator will still need to set the option value either globally, specific to a subnetwork, or specific to a client for the option to have any meaning.

To delete the definition of the option with code 128, type:

```
-> dhcp del 128
```

The values for this option that have been set globally, specific to a subnetwork, or specific to a client will not be removed. The administrator must remove those values explicitly. Well-known type option codes cannot be changed or deleted.

DHCP Information File

DHCP information is kept in the file DHCP.DAT, a self-contained file.

This file contains all DHCP information including:

- the option definitions
- the subnetworks that have been added
- the client lease information
- the option values that have been set

This file can be uploaded/downloaded from one router to another.

Clearing All DHCP Information

If necessary, you can clear all DHCP information from memory, including all leases and all global DHCP information. To do so, enter this command:

```
-> dhcp clear all records
```

At this point, the DHCP information is cleared from memory, but the DHCP.DAT file remains unchanged. To clear the information from the DHCP.DAT file as well, enter:

```
-> save
```

☞ **NOTE:**

You cannot abbreviate the word records in the dhcp clear all records command.

BootP Service

This section first discusses what BootP is and then describes the BootP service available from the router.

BootP Concepts

BootP refers to the Bootstrap Protocol. In general, BootP requests have these purposes:

- To obtain an IP address to use.
- To obtain a TFTP server address and file information to continue the booting up process.

For example, a diskless workstation could use a BootP request to get an IP address for itself, the TFTP server address where it is to get the kernel it is to load and run, and the file name of that kernel.

A BootP server waits for incoming BootP broadcasts from BootP clients. The server looks up the MAC addresses of the incoming BootP request in its database. If the MAC address is found, the server normally responds to the requestor with an IP address. It may also respond with boot information, that is, the IP address of a TFTP server, and the name of a file.

BootP Service by the DHCP Server

BootP is a subset of DHCP. The router has a DHCP (Dynamic Host Configuration Protocol) server (as described in detail on page 4-2). By default, the DHCP server ignores BootP requests. However, if desired, you can enable the DHCP server in the router to process BootP requests. BootP processing can be enabled globally, on a per subnetwork basis, or on a per client (IP address) basis. For more information, see “Managing BootP” on page 4-10.

If the DHCP server in the router is disabled, it, of course, cannot process BootP requests even if BootP processing is enabled. The DHCP server in the router disables itself if one of the following occurs:

- If another DHCP server is active on the network.
- If you enter the commands dhcp disable all and save.
- If the DHCP relay list contains one or more IP addresses.

Relaying BootP Requests

The DHCP relay list is an optional list of IP addresses of servers on the network. You create the list manually; addresses are not automatically added or removed. You add addresses to the list using the dhcp addrelay command and remove addresses from the list using the dhcp delrelay command.

While the relay list contains at least one address, the DHCP server in the router is disabled, and the router forwards all DHCP requests and BootP requests to all servers in the relay list. It forwards every reply received from any of the servers in the relay list to the appropriate LAN.

If you remove all addresses from the DHCP relay list, the DHCP server is re-enabled and resumes processing DHCP requests and also BootP requests if BootP processing is enabled.

Network Address Translation (NAT)

Network Address Translation (NAT) allows devices on the LAN to use private IP addresses that aren't recognized on the Internet. The router supports the following NAT techniques:

Masquerading: One NAT IP address is assigned to many PC IP addresses.

Classic NAT: One NAT IP address is assigned to one PC IP address.

Selective NAT: Specified IP address is assigned based on packet destination.

☞ **NOTE:**

Some applications that use IP or UDP protocols may have problems with Network Address Translation. You may be able to avoid this problem by running in TCP mode or by disabling NAT and running as a subnetwork to your ISP.

Supported applications include AOL chat, CUSeeMe, Doom, FTP, L2TP, HTTP, Kali Netbios over IP, NetMeeting, PCanywhere, Quake, Quicktime Video, Real Audio, RTSP, SGI Media Base, SMTP, StreamWorks, Telnet, TFTP, Unix commands (finger, rcp, rshell, rlogin, whois) and VDO. To read more, see "NetMeeting (H.323) with NAT" on page 4-27.

General NAT Rules

- IP routing must be enabled.
- NAT can be run globally or on a per-remote-router and per-Ethernet-interface basis.
- Some operations will not work. Specifically, services that place IP address/port information in the data may not work until the router examines their packets and figures out what information in the data needs to be changed. Remember that the router is remapping both IP addresses and ports.
- When using NAT with a remote router, either the remote ISP must supply the IP address for NAT translation or the user must configure the IP address for NAT translation locally.
- Any number of PCs on the LAN may have a connection to the same or different remote routers at the same time. In reality, the number of PCs on the LAN that can be supported is limited by the amount of memory consumed by the router to maintain table information and by the number of connections the router "thinks" are currently active. Theoretically, up to 64,000 active connections per protocol type—TCP/UDP—can be concurrently running, if the table space is available.

Masquerading

With masquerading, multiple local (PC) IP addresses are mapped to a single global IP address. Many local (PCs) IP addresses are therefore hidden behind a single global IP address. The advantage of this type of NAT is that users only need one global IP address, but the entire local LAN can still access the Internet. This NAT technique requires not only remapping IP addresses but also TCP and UDP ports.

Each PC on the LAN side has an IP address and a mask. When the router connects to an ISP, the router appears to be a “host” with one IP address and mask. The IP address that the router uses to communicate with the ISP is obtained dynamically (with PPP/IPCP or DHCP) or is statically configured. When the PC connects to the ISP, the IP address and port used by the PC are remapped to the IP address assigned to the router. This remapping is done dynamically.

Client Configuration

The following procedures present client configuration from the CLI, for enabling NAT via the WMI, see “NAT” on page 8-38.

Enable NAT

To enable NAT for a remote interface, use the commands:

```
-> remote setiptranslate on <remotename>

-> save
```

To enable NAT for an Ethernet interface, use the commands:

```
-> eth ip translate on <interface>

-> save
```

The save command makes the above changes persistent across reboots; these changes turn NAT on when the specified interface is used.

Obtain an IP Address for NAT

The IP address (the IP address “*known*” by the remote ISP) used for this type of NAT can be assigned in two ways.

The ISP dynamically assigns the IP address. Use the commands:

```
-> remote setsrcipaddr 0.0.0.0 0.0.0.0 <remotename>

-> save
```

The IP address is assigned locally. Use the commands:

```
-> remote setsrcipaddr ww.xx.yy.zz 255.255.255.255 <remotename>

-> save
```

☞ **NOTE:**

ww.xx.yy.zz is the IP address that the user on the local LAN assigns.

Server Configuration

This section is intended for users and network administrators who wish to allow WAN access to a Web server, FTP server, SMTP server, etc., on their local LAN, while using NAT.

NAT needs a way to identify which local PC [local IP address(es)] should receive these server requests. The servers can be configured on a per-remote-router and per-Ethernet-interface basis as well as globally.

Interface-Specific Commands

You can specify servers for specific remote interfaces and for specific Ethernet interfaces. Servers can also be designated for specific protocols and ports. To enable and disable a local IP address (on your LAN) as the server for a specific remote interface, use the following commands:

```
-> remote addserver <action> <protocol> [<last port> [<first
private port>]] <remotename>
```

```
-> remote delserver <action> <protocol> [<last port> [<first
private port>]] <remotename>
```

To see all of the remote entries, use the command:

```
-> remote list <remotename>
```

To enable and disable a local IP address (on your LAN) as the server for a specific Ethernet interface, use the following commands:

```
-> eth ip addserver <action> <protocol> [<last port> [<first
private port>]] <interface>
```

```
-> eth ip delserver <action> <protocol> [<last port> [<first
private port>]] <interface>
```

☞ **NOTE:**

Enter a save command to make the changes persistent across reboots.

Example 1

Assume that the local LAN network is 192.168.1.0 255.255.255.0. The following commands enable a Telnet server on the local LAN with the IP address 192.168.1.3, and an FTP server with the IP address 192.168.1.2.

```
-> remote addserver 192.168.1.3 tcp telnet router1
```

```
-> remote addserver 192.168.1.2 tcp ftp router1
```

When the local router receives a request from router1 to communicate with the local Telnet server, the local router sends the request to 192.168.1.3. If router1 asks to talk to the local FTP server, the local router sends the request to 192.168.1.2.

Example 2

Assume that the local LAN network is 192.168.1.0 255.255.255.0. When the port value of 0 (zero) is used, it directs all ports of the specified protocol to the IP address specified.

```
-> remote addserver 192.168.1.2 tcp 0 router1
```

☞ **NOTE:**

addserver commands using specific port numbers take priority over the port 0 setting.

192.168.1.4 will be asked to serve requests coming from router1 to the local router. If the local router also has the same Telnet and FTP entries from the previous example, 192.168.1.3 will serve the Telnet request, 192.168.1.2 will serve the FTP request, and 192.168.1.4 will serve any other request, including HTTP, SMTP, etc.

Example 3

In this example, an incoming request on TCP port 9000 will be sent to 192.168.1.10 with the port changed from 9000 to the telnet port (port 23).

```
-> remote addserver 192.168.1.10 tcp 9000 9000 telnet route-in
```

```
-> remote addserver 192.168.1.11 tcp 9001 9001 telnet route-in
```

An incoming request on TCP port 9001 will be sent to 192.168.1.11 with the port changed from 9001 to the telnet port.

Error Message: "Failed to add server"

The error message Failed to add server indicates that a server entry could not be created. This can occur either due to port overlap or due to not enough memory.

Port overlap

For example, you enter:

```
-> remote addserver 192.168.1.10 tcp 9000 9000 telnet router1
```

```
-> remote addserver 192.168.1.11 tcp 9000 9000 telnet router1
```

```
Failed to add server
```

The second command gets an error due to port overlap. If the second server entry was allowed and the remote end sends a server request to port 9000, the router wouldn't know whether to send the request to 192.168.1.10 or 192.168.1.11.

Not enough memory was available to create an entry.

This condition should not ordinarily occur because the amount of memory needed for a server entry is less than 30 bytes. Should this problem occur, it may cause many related problems or failures.

System Commands

The following two commands are used to globally enable/disable a local IP address (on your LAN) as the server for that particular protocol and/or port.

```
-> system addserver <action> <protocol> <port> [<last port>
[<first private port>]]
```

```
-> system delserver <action> <protocol> <port> [<last port>
[<first private port>]]
```

☞ **NOTE:**

Enter save to make the changes persistent across boots.

Examples:

The router sends a server request for SMTP to 192.168.1.5 when such a request comes from any remote router running NAT. The router sends any other server request (tcp or udp) to 192.168.1.6.

```
-> system addserver 192.168.1.5 tcp smtp

-> system addserver 192.168.1.6 tcp 0

-> system addserver 192.168.1.6 udp 0
```

Server Request Hierarchy

As shown earlier, multiple system addserver, remote addserver, and eth ip addserver commands can designate different servers for different protocols, ports, and interfaces. When handling a request from a remote router (to which the local router has NAT enabled), the local router searches the server list for the appropriate server. The following lists the order of search and the command that added the server to the list:

Search Order	Command
1. Protocol and port for a specific interface	**->** remote addserver or **->** eth ip addserver
2. Protocol and port for any interface	-> system addserver
3. Protocol and any port for a specific interface	**->** remote addserver with port *0* or **->** eth ip addserver with port *0*
4. Protocol and any port for any interface	**->** system addserver with port *0*
5. Any protocol and any port for a specific interface	**->** remote addserver with protocol *all* and port *0* **->** eth ip addserver with protocol *all* and port *0*
6. Any protocol and any port for any interface	**->**system addserver with protocol *all* and port *0*
7. Local LAN IP address mapped to the WAN interface IP address.	**->** system addhostmapping
8. If none of the above, the local router selects itself (the local router) as the server.	

Classic NAT

With classic NAT, one PC IP address is translated to one NAT IP address. This NAT technique is primarily used to make certain hosts on a private LAN globally visible and give them the ability to remap these IP addresses as well.

Client Configuration

Classic NAT requires that you first enable NAT Masquerading (as described in the previous section); thus, for the Classic and Masquerading forms of NAT, the clients are configured in the same way; see “Client Configuration” on page 4-18.

Host Remapping

Interface-Specific Commands

You can enable and disable host remapping for specific remote interfaces and for specific Ethernet interfaces. To enable or disable host remapping on a per-remote basis, use these commands:

```
-> remote addhostmapping <first privaddr> <second privaddr>
<first publicaddr> <remotename>

-> remote delhostmapping <first privaddr> <second privaddr>
<first publicaddr> <remotename>
```

Use the command remote addhostmapping whenever a host on the local LAN is known by different IP addresses to different remotes.

To enable or disable host remapping on a per-Ethernet-interface basis, use these commands:

```
-> eth ip addhostmapping <first privaddr> <second privaddr>
<first publicaddr> <interface>

-> eth ip delhostmapping <first privaddr> <second privaddr>
<first publicaddr> <interface>
```

System Commands

Use these commands to enable or disable host remapping system-wide:

```
-> system addhostmapping <first privaddr> <second privaddr>
<first publicaddr>

-> system delhostmapping <first privaddr> <second privaddr>
<first publicaddr>
```

Use the command system addhostmapping whenever a host on the local LAN is known by the same IP address on all remotes.

IP Address Range

The range of local LAN IP addresses to be remapped is defined by <*first private addr*> to <*second private addr*> inclusive. These addresses are mapped one-to-one to the public addresses.

The range of public IP addresses is defined by <*first public addr*> only. The rest of the range is computed automatically (from <*first public addr*> to <*first public addr*> + number of addresses remapped - 1) inclusive.

Multiple-Host Remapping Entries

Users may enter as many host remapping entries as they wish.

Example:

The following entries create three mappings:

- 192.168.207.40 through 192.168.207.49 are mapped to 10.0.20.11 through 10.0.20.20
- 192.168.207.93 through 192.168.207.99 are mapped to 10.0.20.4 through 10.0.20.10
- 192.168.209.71 through 192.168.209.80 are mapped to 10.12.14.16 through 10.12.14.25

```
remote addhostmapping 192.168.207.40 192.168.207.49 10.0.20.11
remote1
remote addhostmapping 192.168.207.93 192.168.207.99 10.0.20.4
remote1
remote addhostmapping 192.168.209.71 192.168.209.80 10.12.14.16
remote1
```

Range Overlap Rules

- The per-interface commands, remote addhostmapping and eth ip addhostmapping have these range overlap rules:

  Private IP address ranges cannot overlap for an interface.

  Public IP address ranges cannot overlap for an interface.

- The global command, system addhostmapping, has these range overlap rules:

  Private IP address ranges cannot overlap for a system.

  Public IP address ranges cannot overlap for a system.

- If a private IP address range for an interface and a private IP address range for the system overlap, the private IP address range for the interface has precedence.
- If a public IP address range for an interface and the public IP address range for the system overlap, the public IP address range for the interface has precedence.
- Private IP addresses and public IP addresses can be the same.

For example, to enable IP/port translation to a remote router and make the IP addresses 10.1.1.7 through 10.1.1.10 globally visible, it is permissible to use either one of the following commands:

```
-> remote addhostmapping 10.1.1.7 10.1.1.10 10.1.1.7 remoteName

-> system addhostmapping 10.1.1.7 10.1.1.10 10.1.1.7
```

If the remapped host's IP address (classic NAT, one-to-one IP address translation) and the masquerading IP address (many-to-one IP address translation) are the same, then NAT masquerading has precedence over classic NAT.

Selective NAT

A third implementation of performing NAT is called Selective NAT. In this method, translation is performed on the basis of the destination address. Selective NAT policies can be configured to specify the destination address and the public address that the private addresses will need to be translated to, if translation is desired.

Creating Policies

The NAT policies define the NAT translation based on the destination address of the outgoing packet. The policies contain the public address that the private addresses will be translated to. Thus, if a selective NAT policy is found for the outgoing packet, the private address on the packet will be translated to be public address specified in the policy.

Selective NAT policies are created with two commands; one that will, based on the destination address, translate the private address to a user-defined public address.

```
system selnat addpolicy <remote addr> <remote mask> trans
<public address>
```

and one that will, based on the destination address, allow the private address to remain visible. These commands are:

```
system selnat addpolicy <remote addr> <remote mask> notrans
```

When policies are created, they are sorted and assigned a policy number on the basis of the subnet mask. The most specific policy will be number policy 1 and applied first followed sequentially by the more general policies.

A default policy can be specified that will be applies to all destinations not defined by other policies. This default policy can provide translation similar to masquerading with the exceptions of a user defined translation address, the destination address range can be more narrowly defined, and any other policies would be acted on first, based on the more specific subnet.

Examples

This command creates the default policy.

```
system selnat addpolicy 0.0.0.0 0.0.0.0 trans 12.35.10.1
```

This command creates a policy that will translate the source address of any packets destined to the subnet 12.16.32.0. to 64.35.6.1.

```
system selnat addpolicy 12.16.32.0 255.255.255.0 trans 64.35.6.1
```

This command creates a policy that, for any packets going to the destination address 10.2.2.2, will have no translation performed.

```
system selnat addpolicy 10.2.2.2 255.255.255.0 notrans
```

The composite effect of these policies will be: Packets destined to any address in the subnet 12.16.32.0 will have the source address translated to 64.35.6.1. Packets going to the destination address 10.2.2.2 will not have any translation done. Packets going to any destination other than the 12.16.32.0 subnet and 10.2.2.2 will be translated to 12.35.10.1.

Viewing Policies

The policy listing is sorted by policy number; showing more specific policies first followed by the more general policies. To list the Selective NAT policies, use the following command:

```
system selnat list
```

The following response would be displayed from the examples policies added previously:

```
-> system selnat list
     Remote address              Action
1. 10.2.2.2/255.255.255.255      No Translation
2. 12.16.32.0/255.255.255.0      Transle to 64.35.6.1
3. 0.0.0.0/0.0.0.0               Transle to 12.35.10.1
```

Deleting Policies

Policies are deleted based on the policy number. To delete a policy, use the following command:

```
system selnat delpolicy <policy number>
```

NetMeeting (H.323) with NAT

NetMeeting is an application that uses the TCP protocol H.323 (and, for certain options, T.120). If all NetMeeting connections are outgoing, NAT does not interfere and no additional configuration is needed. However, if incoming NetMeeting calls from outside the local LAN are to be received, NAT needs additional directions from you.

NAT prevents requests coming from outside the LAN from connecting to private addresses on the LAN unless you specify the connections that are to be allowed.To receive NetMeeting audio and video connections from outside the local LAN while NAT is enabled, you must enter commands to direct the outside connections. To do this, you would enter commands to either:

- direct connections for TCP ports 1720 (h323) and 1503 (t120), or
- map a public IP address to a private IP address on the LAN.

Scenario 1: Global Server Connection

Let's suppose you want one private IP address on the local LAN to receive NetMeeting audio and video connections from outside the LAN while NAT is enabled. To allow this, you specify the IP address on the following command:

```
-> system addserver <ipaddr> tcp h323
```

The NetMeeting options, Share Program, Chat, Whiteboard, and Transfer Files use the TCP protocol T.120. To use these options, enter another command specifying the IP address, as follows:

```
-> system addserver <ipaddr> tcp t120
```

All IP addresses on the LAN can continue to connect to addresses outside the LAN, but only the specified IP address can receive the specified TCP connections from the outside.

Scenario 2: Interface-Specific Server Connection

Scenario 2 is the same as scenario 1, except that you want to limit the connections from outside to a specific interface. For a remote interface, you specify the IP address and the remote name on the following commands:

```
-> remote addserver <ipaddr> tcp h323 <remote>
```

```
-> remote addserver <ipaddr> tcp t120 <remote>
```

For a dual-Ethernet router where the connection to the WAN is through an Ethernet interface, you would use these commands that specify the IP address and the Ethernet interface that is connected to the WAN:

```
-> eth ip addserver <ipaddr> tcp h323 <interface>
```

```
-> eth ip addserver <ipaddr> tcp t120 <interface>
```

Scenario 3: Address Remapping

If the local LAN has more than one IP address visible from the WAN, you could map one of those visible IP addresses to a private IP address on the LAN. The router would then direct all connections for the “outside” IP address to the “inside” IP address. The command to do this is:

```
-> system addhostmapping <private ipaddr> <privateipaddr>
<publicipaddr>
```

The first two parameters specify the first and last addresses in the address range. To remap just one address, you specify the same private address twice and then the public IP address.

Address remapping can also be done for a specific interface. For a remote interface, you would specify the addresses and the remote name on the following command:

```
-> remote addhostmapping <private ipaddr> <privateipaddr>
<publicipaddr> <remote>
```

For an Ethernet interface, you would specify the addresses and the Ethernet interface on this command:

```
-> eth ip addhostmapping <private ipaddr> <privateipaddr>
<publicIpaddr> <interface>
```

Key Enabled Features

The router has several optional features that can be enabled by purchasing Feature Activation keys. Depending on the router configuration when ordered, the Feature Activation keys may have been installed during the router manufacturing process or may need to be installed in the field. These optional features are:

- 3DES Encryption
- DES Encryption
- Internal V.90 modem
- IP stack check
- IP Filtering
- IP Security
- IP Stack
- L2TP Tunneling
- Radius Client
- SSH Secure Shell
- Quality of Service
- Stateful Firewall
- VPN Accelerator

The features are activated by the presence of a specific key file in flash memory. When the appropriate key is present, the feature is enabled and access to the feature is allowed through the command line or Web Management interface (based on user privileges).

Adding and Deleting Feature Keys

A software option key is a 76-character string, unique to a particular router. There are four key types:

- **Activation Key** - used to enable or extend the life of a specified feature. This key is purchased and entered manually.
- **Revocation Key** - indicates a feature key has been revoked. This key is internally created when the command to revoke a feature is issued. the feature will display a key but the feature will not be enabled.
- **Unrevoke Key** - used to nullify a revocation key and re-enable the feature activation key. This key is also purchased and entered manually.
- **Manufacturing Key** - indicates a feature key that was installed during the manufacturing process.

☞ **NOTE:**

Feature keys are generated for a particular device by serial number, feature name, and expiration date, and when added, are stored in the system's memory in an encrypted format; for security purposes, this renders the key information ambiguous and not recoverable.

☞ **NOTE:**

The following commands (key add, update, unrevoke, and delete require a save command to make the changes persistent across a reboot. These commands do not apply to Manufacturing keys.

Feature keys can be added from either the command line or the Web Management Interface (WMI) "Add Feature Page" on page 8-28. When using the Command Line Interface, add the key using the following command:

```
-> key add <keystring>
```

Feature keys are generated with a expiration date. If continued use of the feature is desired, an update key will be necessary to extent the key expiration date. The update key command is used to replace an existing Activation key with a new Activation key. To add the updated Activation key refer to the "Update Feature Page" on page 8-30, or use the following command:

```
-> key update <keystring>
```

Once a feature has been revoked, an unrevocation key must be used to activate the revoked key, the command to add the unrevoke key is shown below. To unrevoke a key via the WMI, see the"Unrevoke Feature Page" on page 8-33. For more information on feature revocation, see "Feature Revocation" on page 4-33.

```
-> key unrevoke <keystring>
```

Features keys can also be deleted from the system. When a key is deleted, all feature configuration information is cleared and access is removed. To delete a key, use the following command or refer to the "Delete Feature Page" on page 8-29:

```
-> key delete <keystring>
```

If desired, the feature can be added again re-using the original activation key; this will not change the expiration date. You may also acquire a new activation key. The feature can also be disabled without deleting the key. For more information on disabling a key, see "Enabling and Disabling Features" on page 4-33.

Key Rules

The following rules apply when adding or deleting feature keys.

- Keys are valid for only the intended target device
- Adding a key will fail if the key string was entered incorrectly or altered
- An feature key cannot be updated if a revoked key exists for the specified feature
- Adding duplicate key strings will be denied
- An update key will over-write an existing active key and immediately update the key expiration date
- A feature key does not have to be disabled to be deleted
- A feature key that is expired or revoked key cannot be deleted

Listing the Installed Feature Keys

To determine which software options are available for your router, refer to the “Key Enabled Feature List Page” on page 8-27 or use the following command.

```
-> key list
```

A typical response is shown below.

```
Feature name  Description        En Rv Ex Installed  Expires
3des          3DES Encryption    1  0  0  08/29/2001 12/31/2001
VPNaccell     VPN Accellerator   1  0  0  08/28/2001 12/31/2001
Intmodem      Internal Modem     1  -  -  --/--/---- --/--/---- Not Inst’d
QoS           Quality of Service -  -  -  --/--/---- --/--/---- Not Inst’d
des           DES Encryption     1  0  0  08/28/2001 12/31/2001
firewall      Stateful Firewall  -  -  -  --/--/---- --/--/---- Not Inst’d
ipcheck       IP stack check     1  -  -  --/--/---- --/--/---- MFG
ipfilter      IP Filter          1- -  -  --/--/---- --/--/---- MFG
                                 -
ipsec         IP Security        -  -  -  --/--/---- --/--/---- Not Inst’d
ipstack       IP Stack           1  -  -  --/--/---- --/--/---- MFG
l2tp          L2TP Tunneling     -  -  -  --/--/---- --/--/---- Not Inst’d
radius        RADIUS Client      -  -  -  --/--/---- --/--/---- Not Inst’d
sshd          SSH Server         -  -  -  --/--/---- --/--/---- Not Inst’d
```

The list displayed provides feature key information such as the installation and expiration date as well as the feature status. Key-enabled features that have not had a key installed are displayed, but the key information fields are blank.

☞ NOTE:

As shown in the example above, some keys may be enabled, but have no installation or expiration date. This indicates the key was enabled in the Manufacturing Block or was a Legacy Key, installed under a previous software version. This is noted in the last column of the key listing.

In addition to the key feature information shown above, the key current key string(s)[1] can also be displayed by entering the optional key list command parameter as shown below.

```
-> key list -l
```

[1] The key string displayed may be the activation or update key that was supplied or the self-generated revocation key if the feature has been revoked.

Feature Status

The current feature status is specified by a *1* in one of the following columns:

- En - indicates the feature is currently enabled.
- Rv - indicates the feature has been revoked.
- Ex - indicates the feature key has expired.

If all columns contain a *0* and the feature key has been added, the feature is currently disabled.

Enabling and Disabling Features

When an initial feature key has been added, the feature is enabled and ready for use. Often, these features may not be required for immediate use or require additional configuration for proper system operation. As an alternative to deleting the feature key, a disable function allows the user to turn the feature on and off without modification of the feature settings or re-entering the key string.

To enable or disable a feature using the WMI, see “Feature Enabled/Disable Page” on page 8-31.

To disable a feature, use the following command:

```
-> key disable <feature_name>
```

☞ **NOTE:**
When a feature is disabled, it cannot be managed from the command line or WMI.

To re-enable a feature, use the following command:

```
-> key enable <feature_name>
```

Feature Revocation

If a feature is no longer necessary or desired, or if you have been directed to render the feature non-functional, this can be performed by entering the following command.

```
-> key revoke <feature_name>
```

When a feature key has been revoked, it cannot be enabled, updated or deleted. The only way to re-establish the feature key (string) is to acquire an update key and unrevoke the feature with the following command:

```
-> key unrevoke <keystring>
```

When an unrevoke key has been entered, the displayed key string will be reactivated with the original expiration date and key string value.

Spanning Tree

The Spanning Tree algorithm allows a bridge to dynamically discover the subnet topology and create a loop free path. When Spanning Tree is enabled, the bridge will transmit configuration Bridge Protocol Data Units (PDUs) to other bridges and from the information received, determine a "root" bridge and a "destination" bridge. When this information is combined with distance calculations, it allows the bridge to determine the optimum way to forward frames. When the optimum route is determined, the other bridge interface is shut down to avoid creating loops.

The Spanning Tree mode is persistent across reboots, but will be disabled if the ATM interface has any error at boot time. Deleting a virtual connection removes it from participating in the Spanning Tree calculations.

Boot Code Options

The router provides a number of options for booting router software.

- You can boot from the router's flash memory, the most common option.
- Or, you can boot across the LAN network from a TFTP server, perhaps to test a new level of router software before downloading it to flash memory.
- You can also boot through a gateway to a WAN. The router allows you to set permanent network boot parameters used during network booting, and it enables you to temporarily override those parameters.
- Finally, the router lets you define the order in which the router boot procedures are performed. You can make changes to the boot procedures and specify network boot parameters by entering manual boot mode.

The next section describes the purpose and functions of the boot code. The section following it, "Manual Boot Mode" on page 4-36, describes a menu of manual boot options.

☞ **NOTE:**

For routers with a reset button, see "Manual Boot Mode" on page 4-36.

What is the Boot Code?

The boot code is responsible for initializing the hardware from an initial power up state and then transferring control to the operating system (kernel).

It does the following major tasks:

- Reads flash memory and does a CRC check and magic number before proceeding
- Performs a power on self test (POST)
- Initializes interface controllers, RAM, and LEDs
- Detects interface types (WAN, console, Ethernet)
- Detects optional VPN hardware (Rapid Secure DES)
- Reports to the console: CRC check, flash memory and RAM sizes, DSL type, and POST results
- Checks whether the reset switch is depressed and skips ASIC load if requested
- Loads the file ASIC.AIC if present
- Reports to the console: the MAC address, WAN modem ID, date/time and the reason for the reboot
- Initializes all RAM to a known content (all zeroes).
- Loads the file KERNEL.F2K from flash memory
  - If the load succeeds, transfers control to the OS (kernel)
  - If load fails, issues a Bootp request
    - If no response, displays the boot menu (see “Manual Boot Mode” on page 4-36).

The boot code communicates to the application it launches (usually, the kernel) information about the hardware capabilities of the router model, including the amount of RAM, the flash memory available for the file system, ports (Ethernet, xDSL, etc.), the CPU type, and clock speed. It continues to provide basic I/O services to the launched application, including the erasure and programming of flash memory.

Manual Boot Mode

When the router is shipped, it is set for automatic boot from flash memory. To change these boot defaults, you must enter manual boot mode.

In manual boot mode, you can:

- change the boot options to allow for network booting.
- change the order of boot procedures.
- perform a manual boot.

The router enters *manual boot mode* if either the kernel is not found in flash memory or a Bootp load from the network fails.

☞ **NOTE:**

If the router has configuration (dip) switches on its back panel, you can select manual boot mode by setting switch 6 down and rebooting or powering up the router. To return to automatic boot mode, set switch 6 up and reboot by selecting Menu Option 1, 2, 3, or 4.

In manual boot mode, the router displays the menu of options shown in Figure 4-1.

```
1. Retry start-up
2. Boot from Flash memory
3. Boot from network
4. Boot from specific file
5. Configure boot system
6. Set date and time
7. Set console baud rate
8. Start extended diagnostics

Enter selection:
```

Figure 4-1: Boot Code Menu

☞ **NOTE:**

Options 6, 7, and 8 do not appear on the model 5950.

Option 1: Retry Start-Up

Select option *1*. Retry start-up to reboot the router in the boot procedure order. The boot procedure order is either the one you have specified or the default order. The default order is to boot from flash memory and then from the network (if defined). If you wish to boot from the network and/or alter the boot procedure order, refer to “Option 3: Boot from Network” on page 4-37.

Option 2: Boot from Flash Memory

Select option *2*. Boot from Flash memory to perform a manual boot from flash memory. If the boot is unsuccessful, the router returns to manual boot mode. (When you first receive the router, it defaults to booting from flash during power-up or automatic reboot.)

Option 3: Boot from Network

Once you have installed router software on a network TFTP server, you can have the router boot across the LAN. Option *3* requests a manual boot from the network. It uses the network boot parameters you have defined using Option *5*.

If you have not defined network boot parameters, the router attempts to locate a BOOTP or RARP server on the network.

- BOOTP can be used to supply an IP address, a TFTP server IP address, and a file name.
- RARP can obtain an IP address, if it knows the MAC address. The router assumes that the RARP server is also capable of performing the duties of a TFTP server and so the router requests the file *KERNEL.F2K* (or the filename assigned when permanent network boot parameters are set.)

If a BOOTP or RARP server exists and is properly configured with the router's MAC address, the router boots from the network.

If the boot from the network is unsuccessful, the router returns to manual boot mode.

Option 4: Boot from Specific File

Select option *4* to temporarily override permanent network boot parameters when you perform a network boot.

1. After you select option *4*, the current default (permanent) parameters are shown.
2. Set new temporary values for the network boot parameters.
3. Press the return key and the router boots from the network using the temporary boot parameters.

If the boot is unsuccessful, the router returns to manual boot mode.

Option 5: Configure Boot System

Select option *5* to specify permanent network boot parameters. This menu is illustrated in Figure 4-2.

Select options *2*, *3*, and *4* to set the three boot parameters (boot IP address, TFTP boot server address, and router software file name on the server). To reset any parameter, press **enter** following the prompt.

```
1. Configure boot order, currently "flash, then network"
2. Set permanent IP address, currently not defined
3. Set permanent TFTP boot server, currently not defined
4. Set permanent IP gateway (boot only), currently not defined
(Option 5 for model 5950 only)
5. Set file name to boot from (FLASH and TFTP), currently
"kernel.f2k"

Hit <return> to leave this menu

Enter selection:
```

Figure 4-2: Network Boot Parameters Menu

The boot IP address is the router LAN IP address used during the boot procedure. This address may differ from the LAN IP address that the router is ultimately assigned. This address is different so that a system can be booted from one subnetwork and then moved to its operational network, if necessary.

The TFTP boot server address is the LAN IP address of the boot server (4 decimals separated by periods).

☞ **NOTE:**

Once you have set a TFTP server address, it is assigned to the router software TFTP facility. This server address is then used whenever a server address is not explicitly specified, including when the copy command is in the form:

```
-> copy tftp:<filename> kernel.f2k
```

The router software file name must be in the format: yyyyyyyy.yyy (similar to the DOS filename format).

Set the boot procedure order. You can specify whether the router boots from flash memory first, from a network TFTP server first, or never automatically reboots.

1. Select step 1 under Configure Boot System, option *5*.
2. Select one of the following
   a. To boot from flash memory first, select option *1*
   b. To boot from the network first, select option *2*
   c. If you select option *3*, the router will always go into manual boot mode; that is, you must always select the boot procedure to be performed.

3. Select option *4* to `Boot through the IP gateway`. In this procedure, the router on the local LAN can boot from a boot server that is not connected directly. Instead, the path to the boot server can include other networks (including the WAN, if adequate routers exist). The gateway must be located on the local LAN and be reachable by the local router.
4. On the model 5950, 5930 and 5935, you can boot from either of two files in flash memory. This can be used to run a test kernel and back up the previous version. Thus, if you select option *5*, you see this prompt:

   ```
   Enter the file name you want to boot from [kernel.f2k]:
   ```

   Enter the file name after the prompt (for example, *test.bin*).

Option 6: Set Time and Date

Select option 6 to set the current time and date. Set the new date in the format mm[/dd[/yy (or yyyy)]]. Set the new time in military format hh[:mm[:ss]]). You are shown the current date and time.

☞ **NOTE:**

Your router is Y2K compliant. If you choose to enter only two digits to specify the year, values greater than 93 translate to 19xx. Values less or equal to 93 translate to 20xx. The router has a one-hundred-year date range (from 1994 to 2093).

If the date is set to zero (0/0/00), the real-time clock is disabled for long-term storage.

When the router is configured by a PC, the GUI overwrites the time and date fields. The router time and date values are copied from the PC time and date values.

Option 7: Set Console Baud Rate

Select option 7 to alter the baud rate that the router uses to communicate over the console port with a terminal emulation program. You can override the default rate of 9600. Remember to set the identical baud rate in your terminal emulation program.

Option 8: Start Extended Diagnostics

Select option 8 to run extended diagnostics. Boot diagnostics are only available on routers with the MC68EN360 processor. These diagnostics run automatically when you power up or reboot the router. You may want to run extended diagnostics if you suspect a hardware problem.

When you select option 8, the following menu is displayed:

Enter the number of each test that you would like to run, or select all tests (+). Then enter . (period) to begin diagnostic testing.

```
   [1] DRAM test
   [2] Parity test
   [3] POST firmware CRC test
   [4] Real-Time Clock chip test
   [5] Timers and Interrupts test
   [6] Multi-port UART (internal loopback) test
   [7] Multi-port HDLC (internal loopback) test
   [8] SCC2 External Loopback test
   [9] SCC3 External Loopback test
   [a] SCC4 External Loopback test
   [b] Ethernet Transceiver (internal loopback)
   test
   [-] Deselect all tests
   [+] Select all tests
   [.] Run selected tests
   [#] Enter debugger
   [/] Exit extended diagnostics (reboot)
```

Figure 4-3: Extended Diagnostics Menu

The debugging mode (option #) is available for use primarily when you encounter a serious problem, in consultation with customer support services.

Identifying Fatal Boot Failures

Fatal boot failures can be identified by the light patterns shown by the LEDs on the front panel of the router.

Non-fatal errors are not indicated by the LEDs, but they do prompt the system to send an explanatory message to the console port.

Normal LED states are described in the Hardware Specifications section of the User Reference Guide. (A copy of the Guide comes with your router and is available on the web site www.efficient.com.) The normal progression of LED states during startup are described in “Using LEDs” on page 7-6.

Normally, during ready state, the TEST LED flashes every two seconds. If this normal “heartbeat” stops, it indicates that the router is locked up and you need to cycle power to reset it.

Routers with Four LEDs

If your router has four LEDs, the pattern of the three LEDs (except the POWER LED) may indicate a fatal error.

☞ **NOTE:**

On some router models, the LINK LED is labeled LAN or RX0/TX0 and/or the WAN LED is labeled VOICE or RX1/TX1.

The error patterns are listed in the following table. (Any other pattern of flashing LEDs indicates an internal error. Should this occur, return the router to the factory for repair or replacement.)

TEST	WAN	VOICE or LAN	Fatal Error
Off	Off	Off	Boot ASIC Load error *or* CPM failure
Off	Off	Blinking green	Timer failure *or* Bad FCS
Off	Blinking green	Off	DRAM failure *or* Interrupt failure
Off	Blinking green	Blinking green	SCC failure *or* Manufacturing information error
Blinking amber	Off	Off	CPU step failure *or* Ethernet loop failure
Fast blink green	Off	Off	Wait stuck in the boot menu; kernel file could be missing.
Blinking green	Off	Off	The router is issuing BootP requests (10-second blink).

Routers with Six LEDs

If your router has six LEDs, the pattern of the four LEDs labeled TEST, LINK, WAN, and LANT may indicate a fatal error. The error patterns are listed in the following table. (Any other pattern of flashing LEDs indicates an internal error. Should this occur, return the router to the factory for repair or replacement.)

TEST	LINK	WAN	LANT	Fatal Error
Off	Off	Off	Blinking green	CPM failure
Off	Off	Blinking green	Off	Timer failure
Off	Off	Blinking green	Blinking green	Bad FCS
Off	Blinking green	Off	Off	DRAM failure
Off	Blinking green	Off	Blinking green	Interrupt failure
Off	Blinking green	Blinking green	Off	SCC failure
Blinking amber	Off	Off	Off	CPU step failure
Blinking amber	Off	Off	Blinking green	Ethernet loop failure
Fast blink green	Off	Off	On, off, or blinking	Wait stuck in the boot menu; kernel file could be missing.
Blinking green	Off	Off	On, off, or blinking	The router is issuing BootP requests (10-second blink).

Any other combinations of the four LEDs flashing in a regular pattern indicates an internal error. Should this occur, return the router to the factory for repair or replacement.

Software Kernel Upgrades

You can upgrade the software kernel by downloading a new version from the LAN or from the WAN.

What is the Software Kernel?

The software kernel is the router operating system; it handles task management, memory management, events coordination, and configuration control. Included with the kernel is a complete DOS-like file system using the on-board flash memory, remote debugging support, console handling, and the software update mechanism.

Specific components include:

- Task Scheduler
- Loadable Module Services
- Event Notification Services
- Memory Management
- Buffer Management
- DOS-like Flash File System
- Inter-Process Communications (IPC)
- Power On Self Test (POST) & Boot Code
- Booting and Upgrading from the LAN

You can download a new version of the router software kernel using a TFTP server that already exists on the LAN. The following steps demonstrate how to boot the router software from the network and copy the image from the network into the router's flash memory. When it first connects to the router, the GUI backs up all the files to a directory called Sxxxxx, where x is the router's serial number.

Booting and Upgrading from the LAN

You can download a new version of the router software kernel using a TFTP server that already exists on the LAN. The following steps demonstrate how to boot the router software from the network and copy the image from the network into the router's flash memory. When it first connects to the router, the GUI backs up all the files to a directory called Sxxxxx, where x is the router's serial number.

Upgrade Instructions

Read the following steps very carefully before you perform an upgrade:

CAUTION:

Warning: Before performing this procedure, make sure that you can successfully boot from the network using the manual boot procedure option 3 or 4. Refer to the section "Option 3: Boot from Network" on page 4-37.

Step 1 Copy the router software file *KERNEL.F2K* (or *KERNEL.FPL* for an IDSL router) to a directory where it can be accessed by a TFTP server. The TFTP server must be on the same LAN as the target router; i.e., there must not be a router or gateway between the target system and the TFTP server. If the TFTP sever is not on the same network as the target router, enter the gateway from the boot menu as described in the previous section.

Step 2 Log into the Command Line Interface.

Step 3 Enter the reboot command to synchronize the file system and reboot the router. Because the kernel is no longer stored in flash memory, the router tries to boot from the network. If you have never set permanent boot parameters, the router attempts to locate a BOOTP or RARP server. If the router successfully reboots from the server, go to step 7.

Step 4 Select option 4 to boot router software from the TFTP server using temporary network boot parameters. You are prompted for:

- the router's boot LAN IP address,
- the TFTP server's IP address,
- the load address, and
- the filename of the router's kernel saved on the server.

Step 5 Note that the LAN IP address is the proper address to use during the network boot and this may differ from the IP address ultimately assigned to the router. Enter the temporary network boot parameters (hit the return key for the load address). If all entered information is valid, the router boots from the network. An example follows:

```
Enter selection: 4
      Enter my IP address:
    128.1.210.65
      Enter server IP address:
    128.1.210.70
      Enter load address [80100]:
      Enter file name: kernel.f2k
```

Alternatively, select option *5* to set permanent network boot parameters and then boot from the network using option *3*. You would use this option if you wish to boot from the network for a period of time before copying the software to flash memory.

Step 6 After the boot is complete, verify that the kernel is running successfully.

Step 7 When you are satisfied that the new kernel is performing as expected, copy the kernel into flash memory in the router by typing the two following commands:

```
-> copy tftp@xxx.xxx.xxx.xxx:sfilename kernel.f2k
-> sync
```

where xxx.xxx.xxx.xxx is the TFTP server IP address, SFILENAME is the server filename of the kernel, and KERNEL.F2K is the name of the file loaded from flash memory by the boot procedure. If you do not specify the server address, a permanent or more recent override TFTP server address will be used, if you have previously defined one. Enter the sync command to commit the changes to flash memory.

CAUTION:
After the kernel is copied, do not power down the router until you have issued either a sync or reboot command to reboot the router. Otherwise, the file will not be written to flash memory.

Step 8 After successfully copying the kernel to the router, reset configuration switch 2 or 6 to the up position (if the router has configuration switches). Then reboot the router from flash memory with the reboot command. If you have altered the boot procedure order in any way, reset to boot from flash memory first. Verify the software revision number with the vers command.

The system is now ready to be re-configured, if necessary. The configuration files are unchanged by the upgrade process.

Task Complete

Upgrading from the WAN

You can download a new version of the router software kernel by using a TFTP server on the WAN. The following steps show you how to copy the software from the WAN into the router's flash memory.

CAUTION:
Before performing this procedure, make sure that you can successfully access the software from the TFTP server.

Step 1 Copy router software KERNEL.F2K to a directory where it can be accessed by a TFTP server.

Step 2 Log in to the Command Line Interface.

Step 3 Copy the kernel into flash memory in the router using the following commands:

```
-> copy tftp@xxx.xxx.xxx.xxx:sfilename kernel.f2k
-> sync
```

where xxx.xxx.xxx.xxx is the TFTP server IP address, sfilename is the server filename of the kernel, and KERNEL.F2K is the name of the file. If you do not specify the server address, a permanent or more recent override TFTP server address will be used, if you have previously defined one.

CAUTION:
After the kernel is copied, do not power down the router until you have either issued a sync command or rebooted the router. Otherwise, the file is not written to flash memory.

Step 4 After successfully copying the kernel to the router, reboot the router from flash memory via the reboot command. If a problem occurs during the upgrading process, try the command again (do not reboot until you have successfully copied the kernel). If you have altered the boot procedure order in any way, be sure to reset the router system to boot from flash memory first. Verify the software revision number by issuing the vers command.

The router system is now ready to be re-configured if necessary. The configuration files are unchanged by the upgrade process.

Task Complete

Quality of Service (QOS)

Mission-critical and real-time Internet applications demand a network that provides high bandwidth and low latency. Such applications cannot tolerate unpredictable degradations of network services. Therefore, network services must contain features that provide adequate assurance of sustained service levels. Quality of Service features actively manage network resources to sustain service levels for priority applications. Some of the benefits associated with Quality of Service include:

- Guaranteed available bandwidth and minimum delays to real-time Voice over IP traffic
- Dynamic allocations of bandwidth to non-critical applications
- User control over network traffic levels, and potential cost-efficiencies
- Advanced differentiation of network services
- Measurement and reporting of network service levels

This router provides Quality of Service using two methods: Differentiated Services Framework (DiffServ) and Weighted Fair Queuing (WFQ).

Differentiated Services Framework (DiffServ) is a facility to prioritize the requirements of each Class of Service (CoS) according to policies and apply policies to network traffic. DiffServ is suited to Metropolitan Area Networks or private networks where control over the infrastructure is guaranteed, and differentiated services can be deployed end-to-end. Applications such as videoconferencing or IP telephony must be able to communicate their service level requirements to an infrastructure that can consistently meet those requirements. To do this, QoS control mechanisms must be present in each network element. This router provides such QoS control mechanisms and can interpret the service requirements indicated by network applications, fully participating in any differentiated services architecture.

To employ DiffServ, each packet of data is tagged with a six-bit pattern known as the DiffServ CodePoint (DSCP), replacing the three IP precedence bits in the ToS byte of the IPv4 header. This tag determines the processing of each packet as a Pre-Hop Behavior (PHB) at each DiffServ node. Each DSCP is read and network resources are allocated to a packet according to the Class of Service defined in its associated policy. When DiffServ is activated on your router, data packets are read and marked according to their DiffServ priority. The packets are then queued and processed according to the QoS policies defined for each class of service. You can create and manage these QoS policies using either the Command Line Interface (CLI) or Web management Interface (WMI).

Weighted Fair Queuing (WFQ) is a flow-based queuing algorithm that performs two functions simultaneously: It schedules priority traffic to the front of the queue to reduce response time, and it fairly distributes remaining bandwidth between remaining queues. Consequently, WFQ ensures that queues are not starved for bandwidth and that traffic service levels are made more predictable. Weighted Fair Queuing adapts automatically to changing network conditions and requires minimal configuration. WFQ is implemented on the router and applies to network traffic passing through it. Unlike DiffServ, external nodes have no effect on QoS through Weighted Fair Queuing.

Weighted Fair Queuing provides a means of ensuring that high priority or mission-critical applications receive adequate levels of bandwidth. This is accomplished by controlling two key factors in QoS policies; priority and weight.

Priority determines the order in which packets will be processed by the router. Weight determines the amount of bandwidth to be allocated to a given application. Manipulation of these two factors determines the quality of service to each application. The router supports four priority levels; High, Medium, Normal and Low. A weight value can be assigned to each of these priority levels from a minimum of 1 to a maximum of 255.

To configure the QoS Priority/Weight Setting via the Web Management Interface, see “QoS Configuration Page” on page 8-52 or from the command line, use the following command:

```
-> qos setweight <high | meduim | normal | low> <weight>
```

QoS Deployment Example

To understand how priority and weight can be used to decide service levels for your applications, consider the following example:

A company decides to use QoS between a branch office and headquarters. There are several network applications to be supported, each with different latency tolerance levels and mission criticality:

- IP telephony - This application requires a substantial amount of bandwidth with minimal network latency. It is a mission-critical business application.
- Videoconferencing - This application also requires a substantial amount of bandwidth with minimal network latency. It is also a mission-critical business application.
- File Transfer Protocol - This application requires a minimum amount of bandwidth and is latency-tolerant. The files may or may not be mission-critical.
- HyperText Transfer Protocol - This application requires modest "bursts" of bandwidth intermittently. It can tolerate network latency, but not excessively. The web content may or may not be mission-critical.
- Simple Mail Transfer Protocol - As a store-and-forward application, email is very tolerant of network latency and requires bandwidth only intermittently. The importance of email messages is extremely variable from the most mission-critical to useless spam.

To support IP telephony and videoconferencing, the network administrator chooses to set the High priority weight to 50%. The administrator assigns a priority of High to IP telephony and videoconferencing in the QoS policies.

The Network Administrator decides to set the Medium priority weight at 25%. File Transfer Protocol is assigned Medium priority in the QoS settings.

Normal priority traffic is assigned a weight of 15%. The network administrator decides that HTTP is a normal priority application and implements the QoS policy accordingly.

The remaining 10% of bandwidth is set as the weight for Low priority applications. Email is given this priority in the QoS policy settings.

☞ **NOTE:**

By default, all traffic that is not associated with a QoS policy is handled as Low priority.

As a result of the QoS policies implemented in our example, IP telephony and videoconferencing data packets will receive high priority queuing, and a minimum of 50% of the total capacity bandwidth at any one time. This minimum bandwidth will always be available to these applications regardless of other traffic on the network at any given time. Because of their high priority, IP telephony and videoconferencing packets will be the last to be dropped during periods of saturation. Additional

bandwidth beyond the 50% minimum will be occupied by these high priority applications in the absence of other traffic. Conversely, when no IP telephony or videoconferencing sessions are occurring, their 50% reserved bandwidth is available for use by other applications, as queued according to their respective priorities.

Concurrently, FTP traffic will queue as medium priority for processing by the router. A minimum of 25% of the total bandwidth capacity is reserved for FTP whenever such traffic is passing through the router. Additional bandwidth may be provided to FTP as opportunities from priority and usage allow. During periods of saturation, medium priority packets will only be dropped when competing with high priority traffic.

Normal priority traffic such as HTTP is processed first in the absence of medium or high priority traffic. Based upon QoS policies in this example, a minimum of 15% of the total available bandwidth is always available to normal traffic. Additional bandwidth is made available to normal traffic as medium and high priority traffic permits. When bandwidth is filled to capacity, normal traffic packets are dropped in favor of medium and high priority traffic, but supersede low priority traffic.

In our example, SMTP and all traffic not specified by a QoS policy is given Low priority. A minimum of 10% of the total bandwidth capacity is allocated to low priority applications. More bandwidth is allocated as network conditions permit. During instances of network saturation, low priority packets are the first to be dropped.

QoS Status

QoS is an optional system feature that is enabled through the use of a Feature Key. Some router configurations may be shipped with the key installed during the manufacturing process. For instruction on how to verify the key is present, or to add the QoS key, see “Key Enabled Features” on page 4-29.

The QoS feature status can be enabled and disabled with the following commands or from the QoS Configuration Page of the WMI:

```
-> qos on
```

This command will enable all user configurable QoS functions. In the ON mode, QoS will forward packets, and set the DiffServ marking based on the defined mapping rules and QoS policies.

```
-> qos off
```

This command will disable all user configurable QoS functions.

Policies

QoS policies are created to specify how data is queued and processed according to it's Diffserv priority. This section provides an overview of how to manage QoS policies.

Creating Policies

When creating a policy, two options are available from the command line. Each of the commands creates a new policy by name; the first command adds the policy to the bottom of the policy list and the second adds the policy to a specified insertion point within the existing policies.

```
-> qos append <policy name>
```

```
-> qos insert <policy name> <insert before this policy>
```

In the Web Management interface, the Policy name is created as part of the policy configuration procedure (see "QoS Policy Configuration page" on page 8-54.)

Policy Parameters

Once a policy has been created, the policy attributes can be configured or modified using the basic command structure shown below. For managing policies through the WMI, see "QoS Policy Configuration page" on page 8-54.

☞ **NOTE:**
A QoS policy status must be disabled before it can be modified or deleted.

```
qos set [<parameter>] <policy name>
```

When configuring QoS policies via the CLI, multiple parameters can be entered in the same command for a single QoS policy; the sequence of parameters in not essential, but each value must be delineated by a prefix that precedes the parameter value. All parameters have a prefix with the exception of the *policy name*, which must be the last parameter entered to designate the target policy, and *status*, which is configured with an alternate command through the CLI. The prefixes and command usage are shown below.

Policy Name - Defines the specific policy.

Status - Enables and disables the QoS policy.

Source IP - Specifies the source IP address or range of IP addresses on which the policy will be applied, or disables source address checking. The command line usage for entering this parameter is:

```
-sa <source address> off | <start address>[:end address>]
```

For example, to add the source address range of *192.168.1.5 to 192.168.1.12* to the policy "*mypolicy*" enter the following:

```
qos set -sa 192.168.1.5 192.168.1.12 mypolicy
```

Dest IP - Specifies the destination IP address or range of IP addresses or disables destination address checking. The command line usage for entering this parameter is:

```
-da <destination address> off | <start address>[:<end address>]
```

Protocol - Specifies the protocol by protocol number or explicitly *TCP* or *UDP* or disables protocol checking. The command line usage for entering this parameter is:

```
-p <protocol> off | <protocol number> tcp | udp
```

Source Port - Specifies the source port or range of ports by number or specific application. Specifying *Off* will disable source port checking. The command line usage for entering this parameter is:

```
-sp <source port> off | <start port number>[:<end port number>]
```

Dest Port - Specifies the destination port or range of ports by number or specific application or disables destination port checking. The command line usage for entering this parameter is:

```
-dp <destination port> off | <start port number>[:<end port
number>] off | ftp | telnet | smtp | http | snmp |tftp | dns |
login | rsh | h323 | t120
```

Priority - Specifies the policy priority, with *normal* the default value. The command line usage for entering this parameter is:

```
-pr <priority> high | medium | normal | low
```

Code Point - incoming - Specifies or defaults the incoming code point. The command line usage for entering this parameter is:

```
-ic <incoming code point> off | <code point>
```

Code Point - outgoing - Specifies or defaults the outgoing code point. The command line usage for entering this parameter is:

```
-oc <outgoing code point> off | <code point>
```

Bidirection - Enables (On) and disables (Off) bidirectional operation of the policy. The command line usage for entering this parameter is:

```
-b <bi-directional> on | off
```

Start Time - Specifies the time of day when the specified policy becomes active. The command line usage for entering this parameter is:

```
-st <start time> <hh:mm>
```

Duration - Specifies the time period for the policy to remain active. The command line usage for entering this parameter is:

```
-du <duration> <hh:mm>
```

Repetition - Specifies the policy as a one-time, repeating, or always-on policy.The command line usage for entering this parameter is:

```
-r <repetition> off | <once<mm/dd/yy>> | <everyday | mon | tue
| wed | thu | fri | sat | sun>
```

Policy Status

As required, each policy can be enabled and disabled ad required using the following commands:

```
-> qos disable <policy name>
```

```
-> qos enable <policy name>
```

Listing Policies

A listing of the QoS queue parameters and all user-configured QoS policies using the following commands:

```
-> qos list
```

This command will display all configured policies by name.

```
-> qos list <policy name>
```

This command usage will display the configuration and parameters of only the specified policy.

Moving Policies

As inbound or outbound packets are processed for QoS, the packet is inspected for attributes that match a QoS policy. If the packet does not matches the first policy it is inspected by the next until it is a match is found. Therefore, as policies are built, it may be necessary to move policies up or down the policies list. To move a policy, use the following commands:

```
-> qos move <policy name> <move to before this policy>
```

This command will move the specified policy to the location preceding the second policy specified.

```
-> qos movetoend <policy name>
```

This command move the specified policy to the end of the QoS policies list.

Deleting Policies

Policies can be deleted by using the following commands:

☞ **NOTE:**
A QoS policy status must be *disabled* before it can be modified or deleted.

```
-> qos del <policy name>
```

Deletes a single QoS policy as specified.

```
-> qos del all
```

Deletes all QoS policies.

Misc. Administrative Functions

The following procedures are miscellaneous functions that facilitate administration of the router.

Setting the System Time and Date

Automatic SNTP requests are generated if the system needs to get the time. You can specify an SNTP server using the sntp server command and a UTC offset with the sntp offset command.

If an SNTP server is not available, the system time and date can be set using the commands listed below, or from the Web Management Interface, “Router Clock Page” on page 8-34.

```
-> date <mm/dd/yy>

-> time <hh:mm:ss>
```

CHAPTER 5

SYSTEM SECURITY

This chapter discusses security features of your Efficient Networks router. A variety of standard features as well as key enabled features provide the following categories of security:

- Local Security
- Network Security
- Data Security

Local security entails limiting and controlling access to the router through any of the user interfaces (serial, WAN and LAN). This is accomplished through User Authentication.

Network security involves protection of the LAN from unauthorized access from outside sources. The router can provide this protection through the use of authentication protocols and filters. Filters are rules that selectively allow or deny information to and from the local network. Filters can be classified as an input filter that screens data coming into the local network, and an output filter that screens data transferred from the LAN.

Network security also includes protection of the router and LAN-side clients as intrusion methods can cause atrophy or outage of router and network services.

Data security is the protection of the actual data traffic itself through a variety of encryption methods.

The sections that follow provide the procedures to employ these security features.

☞ **NOTE:**

In the following procedures, it is assumed you are properly connected to the router and the communication via the Command Line Interface or Web Management Interface (WMI) has been established. If not, see “Installation and Setup” on page 3-1.

User Authentication

User authentication is feature that provides local protection against unauthorized configuration and operation of router. User accounts are established and are then authenticated via three-tiered scheme:

- User verification - Verifies the validity of the user account by username and password. If the user exists, the account status (enabled/disabled) is verified.
- User access - Verifies the user account has privilege for the access method (interface) being attempted.
- User management class - Verifies the user has privilege to access or execute specified command classes.

The first authentication is performed when an access request is made to the system. The username and password pair are supplied by the user and verified in the user database (specified by the User Lookup). If the pair is authenticated and the user account is enabled, the next authentication is performed on the access method. If the source of the access request (console, WAN or LAN) is authorized for the account, the session is allowed. upon successful connection, the user prompt will reflect the username as shown below. If any of the criteria is not authenticated, the session is not allowed.

WEB Management Interface	Command Line Interface
	`myname@console->`
	***Note**: Command line sessions also display the access method of the connection.*

The third authentication action is management class verification. Each command (of the command line interface) or page (of the WEB management interface) is associated with one or more management classes. When the user attempts to execute a command, or view a page, the action (request) is checked against the account management class and read/write privileges and a decision is made to allow access or deny the request. Management class privileges are described in more detail in “Management Classes” on page 5-3.

User Account Information

Each user account is composed of a username, password, and corresponding privileges. The system supports up to 15 user accounts that are stored in the local file system. Additional accounts can be configured if a RADIUS Server is configured and the key-enabled feature Radius Client has been enabled.

There are two methods for creating a user account via the command line interface:

- Creating an account with a Username and Password, then adding specific Management Classes and Access Privileges.
- Creating an account with a Username and Password and assigning privileges through built-in Templates.

Username and Password

A username and password is the minimum requirement for adding a user account. Both the user name and password can be any ASCII string from 6 to 32 characters long; these parameters are case-sensitive. The user account password information is stored on the system in an encrypted format for greater security.

☞ **NOTE:**

Passwords are never displayed in clear text format through any of the user interfaces; passwords will appear as '********'.

Creating an account with only a username and password will be disabled by default. The user will not be able to connect to the router since no privileges have been defined, even after the account has been enabled.

Once a user account has been enabled and the user has access privileges, the user can change the account password with the password command or through the WMI, Change Password form.

Management Classes

All system operations, through both the command line or WEB management interface are partitioned into functional groups, or management classes. Management privileges categorize the system operations to which a user account has access. A management class overview in Table 5-1.

Table 5-1: Management Classes

Class	Functional Areas
Voice	Voice operations and shared network functions
Network	File system, System Interfaces, SNMP, DHCP, NAT, remote commands
System	Various system administrative tasks
Security	SSH, L2TP, IPSec, Firewall
Admin	User Management, Key Enabled Features
Debug	Debug functions

Access to system operation can be further administered by granting read or write privileges to a user. These privileges are summarized in Table 5-2.

Table 5-2: Read / Write Privileges

Interface	Read-Only[a]	Write / Both
Command Line	Allowed execution of commands that generate a response only, *(e.g. list commands)*. All write commands are disabled.	Allowed to execute both read and write commands within specified management class(es).
Web	May view informational pages. No configuration changes are allowed.	Can view and execute changes to all WMI pages within specified management class(es).[b]

[a] Users with read-only privilege can still change their password.
[b] Command execution through the WMI command line page will be limited to the specified management class privileges of the user.

Access Privileges

The access privilege defines the authorized methods in which the user can access the router; WAN, LAN, or console.

Templates

When creating a user account, multiple commands are required to define a user's management class(es) and access method(s). To ease the configuration, pre-defined user templates are available that group multiple management class privileges to a logically defined user type. The template Access privileges for WAN, LAN and Console are granted by default for each

The template characteristics are shown in Table 5-3. The templates characteristics can also be displayed via the command line using the user list template command or via the WMI, "User Management" on page 8-17.

Table 5-3: User Templates

Privilege Type	Authorization
Super User	
Mgmt Class (read):	Network, System, Admin, Voice, Security, Debug
Mgmt Class (write):	Network, System, Admin, Voice, Security, Debug

Table 5-3: User Templates (Cont.)

Privilege Type	Authorization
Access:	WAN, LAN, Console
Status:	Enabled
Voice Manager[a]	
Mgmt Class (read):	System, Voice
Mgmt Class (write):	System, Voice
Access:	WAN, LAN, Console
Status:	Enabled
Network Manager	
Mgmt Class (read):	Network, System
Mgmt Class (write):	Network, System
Access:	WAN, LAN, Console
Status:	Enabled
Security Manager	
Mgmt Class (read):	System, Security
Mgmt Class (write):	System, Security
Access:	WAN, LAN, Console
Status:	Enabled
Viewer	
Mgmt Class (read):	Network, System, Voice, Security
Mgmt Class (write):	None
Access:	WAN, LAN, Console
Status:	Enabled

[a] The Voice Manager template option is not available on non-voice products.

Initial (Default) Setting

When the router is shipped from the factory with a default configuration, a single Super User account exists with the following username and password:

Username: superuser

Password: admin

CAUTION:

After the initial login, you will be required to change the factory default password. It is also suggested that the default username be changed.

User Lookup

Since user accounts can be maintained both locally and remotely, the user look-up parameter defines the search order (primary and secondary) for access queries. The options are local, radius, and none. Local will query the local user database, held in flash memory. The RADIUS client will generate an encrypted Access Request to a configured RADIUS server. None indicates only the specified method will be used.

NOTE:

One method will always, by default, be set to *local* if both primary and secondary methods are specified; this ensures access will always be available locally.

If the primary method fails to authenticate the username and password, the second method (if configured) will be attempted. If both primary and secondary methods fail, the user is returned a login prompt and must re-submit the information.

When configuring the lookup order via the command line, the first parameter indicates the primary method, and the second, if entered, specifies the secondary method. If the primary is set to radius, the secondary will default to local.

Procedures

User Look-up configuration via the Web Management Interface on the User Lookup Configuration. The command line procedures are listed below.

The following command will set the user look-up order to *local* as primary and *Radius* as secondary:

```
-> user set lookup local radius
```

This command will set the user look-up order to *Radius* as primary and will by default, set the secondary to *local*:

```
-> user set lookup radius
```

Subsequent user lookup commands do not edit the existing configuration but overwrite the values; if two methods are desired, they must both be specified.

The current user look-up settings can be viewed on the command line by entering the following command:

```
-> user list lookup
```

Creating a User Account

The following section provides example procedures for creating user accounts through the command line interface. For information on the creating user accounts through the WMI, see “User Management” on page 8-17. For more information on adding an account to a RADIUS Server, refer to the documentation supplied with the RADIUS Server Software.

☞ **NOTE:**

In the following examples, the username *myname* and password *secret* will be used.

Adding a User Account with No access

In the following example, a user account is created with no privileges; the user cannot access the router.

```
-> user add user myname secret
```

Adding an account in a disabled state

In the following example, a user account is created with read and write management privileges to management class operations defined in the Network template; the user cannot access the router.

```
-> user add user myname secret network write disabled
```

Adding an account with read-only privilege

In the following example, a user account is created with read-only privilege for the management class operations defined in the Network template; the user is enabled and can access the router.

```
-> user add user myname secret network read enable
```

Managing User Accounts

The following section provides an overview of commands that facilitate the management of existing user accounts through the command line interface. For information on the managing user accounts through the Web management interface, see “User Management” on page 8-17.

Listing users and account information

The following command will list all user account information stored in the local (flash memory) user database.

```
-> user list
```

A typical response is shown below; the accounts are listed in chronological order with the oldest account listed first.

```
Printing local user database (3 total valid users)...
Username: superuser
Password: ****************
Mgmt Class(read): NETWORK SYSTEM PRIV VOICE SECURITY DEBUG
Mgmt Class(write): NETWORK SYSTEM PRIV VOICE SECURITY DEBUG
Access: WAN LAN CONSOLE
Status: ENABLED

Username: myname
Password: ****************
Mgmt Class(read): NETWORK SYSTEM VOICE SECURITY DEBUG
Mgmt Class(write): NETWORK SYSTEM DEBUG
Access: WAN LAN CONSOLE
Status: ENABLED

Username: VoiceAdmin
Password: ****************
Mgmt Class(read): NETWORK SYSTEM VOICE
Mgmt Class(write): NETWORK SYSTEM VOICE
Access: WAN LAN CONSOLE
Status: DISABLED
```

☞ **NOTE:**

For security reasons, user passwords are not displayed; they are displayed as "**********".

Changing a user password

Since user password information is stored in an encrypted format and is never displayed, user passwords cannot be recovered. The following command will re-issue a password (*newsecret*) for the user account *myname*.

```
-> user set password myname newsecret
```

Enable / Disable an account

The following commands enable or disable an existing user account. The following characteristics apply when enabling or disabling an account:

- Enabling an account activates the assigned account privileges.
- Disabling an account de-activates an account, but does not modify any account privileges.
- If a user account has been configured with a username and password only, the account will still not be enabled since no privileges have been granted.

The commands to enable or disable an account are listed below.

```
-> user enable myname
```

```
-> user disable myname
```

Changing account class privileges

A user's class privileges can be modified to:

- Add or delete a management class
- Change the read /write privilege of a currently configured class

A summary of management classes are can be found in Table 5-1. When a management class is added to an existing user account, the class templates are not supported; single management classes are added or deleted.

Management class changes are supported through the WMI, on the xxx form. Changes via the command line are made by entering both the management class and the read / write privilege; specifying *write* enables both read and write privileges.

To add a management class privilege to an account, use the following command:

```
-> user add class network write myname
```

To delete a management class privilege from an account, use the following command:

```
-> user delete class voice write myname
```

If an account currently has both read and write privileges for a management class, adding the same management class with read-only privilege will not delete the write privilege; the management class must be deleted for the account, then added again with read-only privilege specified.

Changing account access

The Access Privileges for an account can be added or deleted with the following commands:

```
-> user add access lan myname

-> user delete access console myname
```

Adding a read only class account

In the following example, a user account is created with read-only privilege for the management class operations defined in the Network template; the user is enabled and can access the router.

```
-> user add user myname secret network read enable
```

To add a user account is created with read-only privilege for the management class operations defined in the Network template; the user is enabled and can access the router.

```
-> user add user myname secret network read enable
```

Radius

Remote Authentication Dial In User Service or (RADIUS) is client-server based access control and authentication feature. The RADIUS client is a key-enabled feature that resides locally on the router and works in conjunction with a variety of RADIUS Server applications.

The client is responsible for passing user information to designated RADIUS servers, and then acting on the response which is returned. RADIUS servers are responsible for receiving user connection requests, authenticating the user, and then returning all configuration information necessary for the client to deliver service to the user.

When the router is configured to use RADIUS, a user attempting to login presents authentication information (Username and Password) to the router. Upon receipt, the router will, if defined in the User Lookup setting, attempt to authenticate using RADIUS. To do so, the router's RADIUS Client creates an "access-request" containing username, the user's password, method in which the user is accessing the system. The password is hidden using a method based on the RSA Message Digest Algorithm MD5 [3].

The Access-Request is submitted to the RADIUS server via the network. If no response is returned within a length of time, the request is re-sent a specified number of times. The router's RADIUS client can also forward requests to a secondary server in the event that the primary server is down or unreachable.

Once the RADIUS server receives the request, it validates the RADIUS client that sent the request. A request from a client for which the RADIUS server does not have a shared secret is discarded. If the client is valid, the RADIUS server consults a database of users to find the user whose name matches the request. The user entry in the database contains the required elements for authentication including the usename, password, access and management privileges.

Client-Server Security

Transactions between the client and server are authenticated through the use of a shared secret, which is never sent over the network. In addition, any user passwords are sent encrypted between the client and RADIUS server, to further secure account passwords.

Radius Client Configuration Procedures

The following paragraphs describe the procedures to configure the RADIUS client through the command line interface. The RADIUS client is a key-enabled feature and is not available without a valid key. For more information on adding a key, see “Key Enabled Features” on page 4-29.

For RADIUS client configuration via the WMI, see “User Lookup Configuration” on page 8-22.

Secret Configuration

The RADIUS client is authenticated by a RADIUS server through a shared secret. When configuring the shared secret:

- If multiple RADIUS Servers (a primary and secondary are supported) are configured, one shared secret is required per server.
- On the command line the primary server is specified as ’*1*’ and the secondary server is specified as ’*2*’. If the server is not specified, the command will, by default, configure for the primary server.
- Only one shared secret (for primary or secondary server) can be set per command.
- The shared secret’s composition is an ASCII string up to 64 characters.
- Secrets are never displayed in plain text format and are encrypted during client-server transactions.

The following command will set the shared secret for the secondary server to *noclues*.

```
-> radius set secret 2 noclues
```

The following command displays the shared secret.

```
-> rad list secret
```

Server Information Configuration

For the RADIUS client and server to transact, the RADIUS client must know the location and sequence of the RADIUS server(s). The location is defined by IP address (in dotted-decimal notation) and port value. When configuring the RADIUS server address:

- On the command line the primary server is specified as '*1*' and the secondary server is specified as '*2*'. If the server is not specified, the command will, by default, configure for the primary server.
- Only one server address and port entry can be set per command.
- The default RADIUS server port value is 1812.

The following commands will set the primary and secondary RADIUS server addresses and port values.

```
-> radius set server 192.161.12.105 1812 1

-> radius set server 192.170.7.103 1812 2
```

To delete a RADIUS server (1 = primary, 2 = secondary) entry, enter the command as shown below (deleting the secondary RADIUS server):

```
-> rad deleteserver 2
```

The current RADIUS server entries can be displayed using the following command:

```
-> rad list server
```

Server Retries Configuration

If the primary server cannot be reached on the first attempt, the RADIUS client will, by default, attempt three additional times. If the server still cannot be contacted, the client will attempt to contact the secondary server. The following command allows changing the number of retries; the valid range is 0 to 5.

```
-> rad set retries 5
```

Server Retries Timer

When a RADIUS server cannot be reached, a response timeout is set, by default to 3 seconds. This command sets the number of seconds between retry attempts to the RADIUS server.

```
-> radius set timeout 4
```

Radius Server Configuration

While vendor specific RADIUS servers may vary in their operation and configuration, the following information will be required for transacting with the router's RADIUS client. For information on adding user accounts and specific privileges, see the RADIUS Server vendor documentation.

Vendor ID 1548

Vendor Type 1

Vendor Attribute ENI-Priv

Table 5-4: RADIUS Server Attribute Value List

Privilege	Hex value	Comment
Voice RO	0x00000001	Voice, Read-Only
Voice RW	0x00000002	Voice, Read-Write
Data RO	0x00000004	Data, Read-Only
Data RW	0x00000008	Data, Read-Write
WAN RO	0x00000010	WAN, Read-Only
WAN RW	0x00000020	WAN, Read-Write
Network RO	0x00000014	Network, Read-Only
Network RW	0x00000028	Network, Read-Write
Security RO	0x00000040	Security, Read-Only
Security RW	0x00000080	Security, Read-Write
Inventory RO	0x00000400	Inventory, Read-Only
Inventory RW	0x00000800	Inventory, Read-Write
System RO	0x00000500	System, Read-Only
System RW	0x00000A00	System, Read-Write
Admin RO	0x00001000	Privileged, Read-Only
Admin RW	0x00002000	Privileged, Read-Write
Debug RO	0x00004000	Debug, Read-Only
Debug RW	0x00008000	Debug, Read-Write
Access Port	**Hex value**	**Comment**

Table 5-4: RADIUS Server Attribute Value List

Privilege	Hex value	Comment
Serial-Console Port	0x00010000	Serial-Console Port Access
LAN Port	0x00020000	LAN Port Access
WAN Port	0x00040000	WAN Port Access
Account Enabled	0x80000000	Account Enabled

Controlling Remote Management

Several methods are available for controlling remote management of the system, these methods include:

- Disabling Remote Management by disabling post access for the specified service.
- Validating Clients based on the remote IP address.
- Restricting Remote Access by re-defining conventional (or default) port numbers to alternate port numbers.
- Changing the SNMP Community Name or SNMP Password
- Disabling WAN Management, allowing management functions from the LAN-side only.

With the following security control features, the user can control remote management of the router via Telnet, HTTP, Syslog, and/or SNMP. Disabling SNMP stops an SNMP Manager from accessing the router, which in some environments is desirable.

Router system event messages can be automatically sent to a Unix Syslog server. The system syslogport and system addsyslogserver commands control the port number and valid IP addresses. For more information, see “Syslog Client” on page 7-1.

Disabling Remote Management

To completely disable remote management, enter the following commands from the command line:

```
-> system telnetport disabled
-> system snmpport disabled[1]
-> snmp snmpport disable[1]
-> system httpport disabled
-> system syslogport disabled
-> save
-> reboot
```

Re-enabling Remote Management

To reestablish the disabled remote management services, restore the default values with the commands:

```
-> system telnetport default
```

[1] Command functions are identical.

```
-> system snmpport default[2]
-> snmp snmpport default[2]
-> system httpport default
-> system syslogport default
```

Validating Clients

The following commands are used to validate clients for Telnet, SNMP, HTTP, or Syslog. They define a range of IP addresses that are allowed to access the router via that interface. Only the IP addresses in the range specified for the interface can access the router via that interface. This validation feature is off by default.

Multiple address ranges can be specified for each filter. If no range is defined, then access to the router is through the LAN or WAN.

☞ **NOTE:**
These commands do not require a reboot and are effective immediately.

```
-> system addtelnetfilter <first ip addr> [<last ip addr>] | lan
-> system addsnmpfilter <first ip addr> [<last ip addr>] | lan [3]
-> snmp addsnmpfilter <first ip addr> [<last ip addr>] | lan [3]
-> system httpport <first ip addr> [<last ip addr>] | lan
-> system addsyslogfilter <first ip addr> [<last ip addr>] | lan
```

Example:

```
-> system addsnmpfilter 192.168.1.5 192.168.1.12
```

To delete client ranges previously defined, use these commands:

```
-> system deltelnetfilter <first ip addr> [<last ip addr>] | lan
-> system delsnmpfilter <first ip addr> [<last ip addr>] | lan [4]
-> snmp delsnmpfilter <first ip addr> [<last ip addr>] | lan [4]
-> system delhttpfilter <first ip addr> [<last ip addr>] | lan
-> system delsyslogfilter <first ip addr> [<last ip addr>] | lan
```

To list the range of allowed clients, use the command:

```
-> system list
```

[2] Command functions are identical.
[3] Command functions are identical.
[4] Command functions are identical.

Restricting Remote Access

To allow remote management while making it more difficult for non-authorized persons to access the router, you may redefine the ports to a less well-known value. When Network Address Translation (NAT) is used, this port redefinition feature also allows you to continue using the standard ports with another device on the LAN (provided the appropriate NAT server ports commands are issued), while simultaneously managing the router (with non-standard ports).

For example, the following commands redefine the Telnet, SNMP, HTTP, and Syslog ports:

```
-> system telnetport 4321
-> system snmpport 3214 [5]
-> snmp snmpport 3214 [5]
-> system httpport 5678
-> system syslogport 6789
```

Changing the SNMP Community Name

Changing the SNMP community name from its default value of “public” to another string may further enhance SNMP security. This string then acts like a password, but this password is sent in the clear over the WAN/LAN, in accordance with the SNMP specification.

Use the following commands to change the SNMP community name.

```
-> system community <new community name> [6]
-> snmp community <new community name> [6]
-> save
-> reboot
```

[5] Command functions are identical.
[6] Command functions are identical.

Disabling WAN Management

You can allow management of the router on the local LAN, but not over the WAN. If the router has been configured to use Network Address Translation (NAT), you can define two servers that do not exist on the LAN side to handle WAN SNMP and Telnet requests, and thus WAN management of the router cannot occur.

The following example shows how this is done. It assumes there is no computer at 192.168.254.128.

```
-> system addserver 192.168.254.128 udp snmp

-> system addserver 192.168.254.128 tcp telnet

-> system addserver 192.168.254.128 tcp http

-> save

-> reboot
```

Secure Mode Access

Secure Mode is a feature that can restrict system access to the use of only secure channels. The secure channels supported by the system are:

- IP Sec
- SSH
- CLI access through the serial port

IPSec (Internet Protocol Security) and SSH are Key Enabled Features that provide the secure modes of IP-based connectivity allowed when secure mode access is enabled. The serial port is considered secure, not by encryption, but by the ability to physically secure access the router's serial port.

Trusted and Untrusted Interfaces

Secure mode can be employed for the WAN interface, LAN interface or both. When secure mode is enabled, an interface can be designated as trusted, indicating that unsecure connections are allowed via the specified interface. Designating an interface as untrusted will enforce the requirement of a secure channel for access via the specified interface. By default, the WAN interface is untrusted and the LAN interface is trusted.

Secure Mode Management

The following procedures are used to configure Secure Mode via the command line interface, for configuration via the Web Management Interface, see "Secure Mode Configuration" on page 8-23.

The following command is used to enable and disable secure mode. When secure mode is enabled, management access of the system is allowed only through secure channels for untrusted interfaces.

```
system securemode set <enable | disable>
```

☞ **NOTE:**

When secure mode is enabled, all current non-secure connections via an untrusted interface will be terminated immediately with the exception of inbound file transfers. Inbound file transfers will allowed to complete prior to session termination.

To designate an interface as trusted or untrusted, use the following commands. These settings are enforced only if secure is enabled.

```
system securemode set lan <trusted | untrusted>
```

```
system securemode set wan <trusted | untrusted>
```

The current secure mode settings can be displayed using the following command:

```
system securemode list
```

PAP/CHAP Security Authentication

The router supports PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) under PPP.

Security authentication may not be required due to the nature of the connection in a DSL environment (traffic occurs on a dedicated line/virtual circuit. However, authentication may be specifically required by the remote end, the ISP, or the NSP. When authentication is not required, security can be disabled with the remote disauthen command.

PAP provides verification of passwords between routers using a two-way handshake. One router (peer) sends the system name and password to the other router. Then the other router (known as the authenticator) checks the peer's password against the configured remote router's password and returns acknowledgment

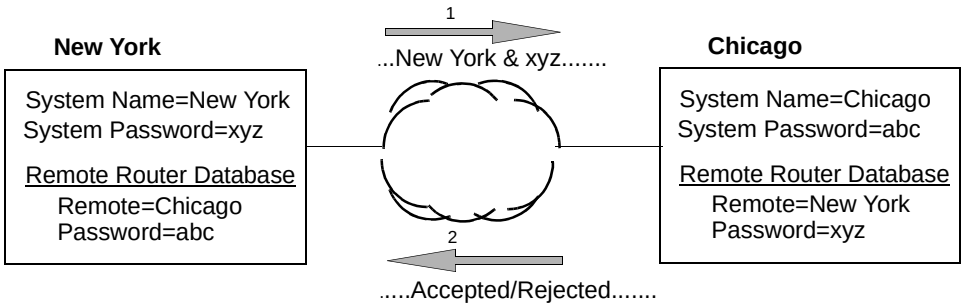


Figure 5-1: PAP Authentication

CHAP is more secure than PAP because unencrypted passwords are not sent across the network. CHAP uses a three-way handshake. One router (known as the authenticator) challenges the other router (known as the peer) by generating a random number and sending it along with the system name. The peer then applies a one-way hash algorithm to the random number and returns this encrypted information along with the system name.

The authenticator then runs the same algorithm and compares the result with the expected value. This authentication method depends upon a password or secret known only to both ends.

Authentication Process

The authentication process occurs regardless of whether a remote router connects to the local router or vice versa, and even if the remote end does not request authentication. It is a bi-directional process, where each end can authenticate the other using the protocol of its choice (provided the other end supports it).

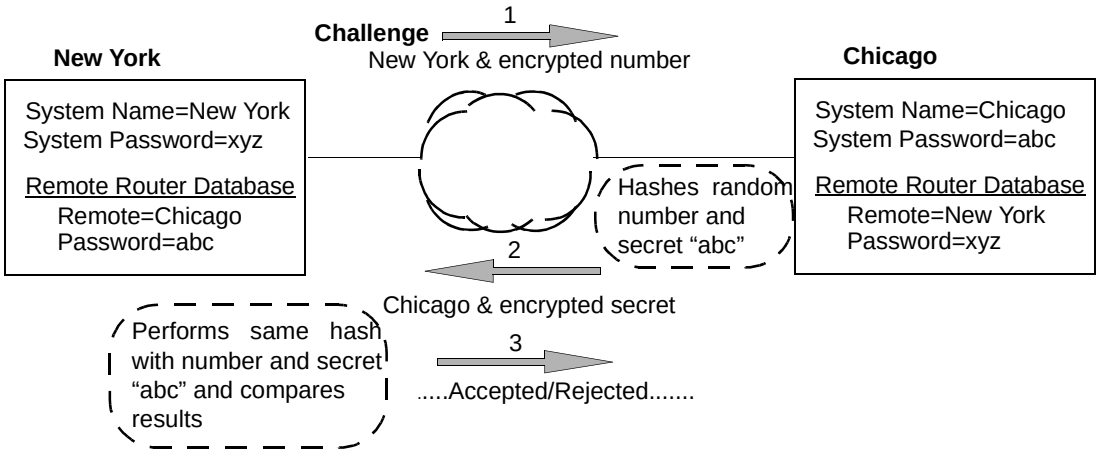


Figure 5-2: CHAP Authentication

During link negotiation (LCP), each side of the link negotiates which protocol to use for authentication during the connection.

☞ **NOTE:**

If desired, you can override the negotiation of an authentication protocol and force the local router to use the designated protocol. To designate PAP or CHAP, use the system authen command.

If both routers have PAP authentication, then they negotiate PAP authentication. Otherwise, the local router always requests CHAP authentication first; if CHAP is refused, PAP is requested. If the remote does not accept either PAP or CHAP, the link is dropped; i.e., the router does not communicate without a minimum security level. On the other hand, the local router does accept any authentication scheme required by the remote, including no authentication at all.

CHAP Authentication

For CHAP, the router issues a CHAP challenge request to the remote side. The challenge includes the system name and random number. The remote end, using a hash algorithm, transforms the name and number into a response value. When the remote end returns the challenge response, the router can validate the response challenge value using the entry in the remote router database. If the response is invalid, the call is disconnected.

If the other end negotiated CHAP, the remote end can, similarly, request authentication from the local router. The router uses its system name and password to respond to the CHAP challenge.

PAP Authentication

For PAP, when a PAP login request is received from the remote end, the router checks the remote router PAP security using the remote router database. If the remote router is not in the remote router database or the remote router password is invalid, the call is disconnected. If the remote router and password are valid, the local router acknowledges the PAP login request.

If PAP was negotiated by the remote end for the remote-side authentication, the router issues PAP login requests only if it knows the identity of the remote end. The identity is known if the call was initiated from the router, or if the remote end returned a successful CHAP challenge response. For security reasons, the router never identifies itself using PAP without first knowing the identity of the remote router.

If PAP was negotiated by the remote end for the local side of the authentication process and the minimum security level is CHAP, as configured in the remote router database, the link is dropped as a security violation.

Authentication Passwords

Access to the router is controlled by an User Authentication. As part of the router configuration, you may set the following authentication passwords:

System authentication password - the default system password used to access any remote router. Remote sites use this password to authenticate the local site. This default authentication password is set by the system passwd command.

System override password - optional password used only to connect to a specific remote router for authentication by that remote site. To specify a unique system override password for a remote router, use the remote setourpasswd command. This password is used instead of the general system password only for connecting to a specific remote router. This allows you to set a unique CHAP or PAP authentication password for authentication of the local site by the remote site only when the router connects to that remote site.

A common use for the system override password is to set the password assigned to you by your Internet Service Provider (ISP). Similarly, the system name of the local router (set by the command system name) can be overridden for connecting to a specific remote with the remote setoursysname command.

Remote authentication password - password used by the router to authenticate the remote site. Each remote router entered in the remote router database has a password used when the remote site attempts to gain access to the local router. To set the remote authentication password, use the remote setpasswd command.

Authentication Levels

The router also uses security levels, as follows:

- **Remote authentication protocol** — Each remote router entered in the remote router database has a minimum security level that must be negotiated before the remote router gains access to the local router.
- **System authentication protocol** — A system-wide control is available for overriding the minimum security level in the entire remote router database.

IP Filtering

IP filtering is a type of firewall used to control network traffic. IP filtering provides the ability to specifically protect some services on the LAN while providing external access to other services. It is a highly flexible means by which to control exactly which network traffic will be allowed into or out of your LAN and which traffic should be denied. It will protect against Denial of Service attacks and log suspicious activities and can also be used to keep certain users on the LAN from accessing the Internet. IP filtering can be used in conjunction with NAT, so you don't have to change an existing configuration to add more security.

The process involves filtering packets received by an interface and deciding whether to forward or to discard them. Filtering is performed for each interface; since a router can support multiple PVCs over the same DSL line, there are actually virtual interfaces separate from physical interfaces. One virtual WAN interface might go to the Internet and another virtual interface might go to a Corporate LAN, but both of these are carried over the same physical WAN interface. So, in addition to applying a single filter on a physical interface, filters should be created for each virtual interface.

Filters and Interfaces

When IP filtering is used, the router examines information for each IP packet, such as the source and destination addresses, ports, and protocols, and then screens (filters) the packets based on this information. If the packet matches the conditions of a filter, the router acts as directed by the filter, that is, it accepts, drops or rejects the packet.

As mentioned above, filters operate at the interface level. Each interface can have up to four lists of filters associated with it: Input filters, Receive filters, Transmit filters, and Output filters. Figure 5-3 illustrates the filtering process.

Input Filters

When a packet arrives at an interface, the router compares the packet to the list of input filters. The first filter that matches the packet determines whether the packet is accepted, dropped, or rejected. If no filter matches the packet, the packet is accepted.

If the packet is accepted, the next step is Network Address Translation, if NAT is enabled for the input interface. For more information on Network Address Translation, see “Network Address Translation (NAT)” on page 4-17.

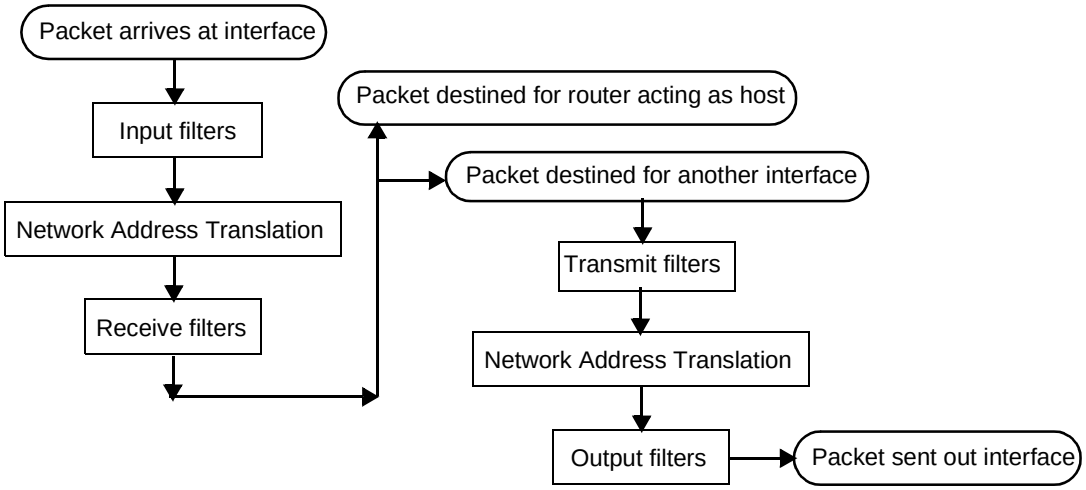


Figure 5-3: IP Filtering Process

Receive Filters

The router next compares the packet to the list of receive filters for this interface. Again, the first filter in the list that matches the packet determines whether the packet is accepted, dropped, or rejected. If no filter matches the packet, the packet is accepted.

Receive filters are applied before the packet destination is determined by the routing table. The packet may be destined for the router itself and/or destined for output to another interface.

☞ **NOTE:**

If Network Address Translation is disabled, the Receive filter list is checked immediately after the Input filter list. In this case, identical Input and Receive filters have the same effect (see the examples at the end of the IP Filtering section.)

Transmit Filters

If the packet is destined for another interface, the router compares the packet to the list of transmit filters for this interface. The first filter that matches the packet determines whether the packet is accepted, dropped, or rejected. If no filter matches the packet, the packet is accepted.

If the packet is accepted, Network Address Translation is performed, if Network Address Translation (NAT) is enabled for the output interface.

Output Filters

Finally, the router compares the packet to the list of output filters for this interface. The first filter that matches the packet determines whether the packet is accepted, dropped, or rejected. If no filter matches the packet, the packet is accepted.

The packet, if accepted, is then sent out the interface.

☞ **NOTE:**

If Network Address Translation is disabled, the Output filter list is checked immediately after the Transmit filter list. In this case, identical Transmit and Output filters have the same effect

Filter Actions

A filter action can be applied to a packet at each of the four filtering points (Input, Receive, Transmit, and Output). If, at that point, a given filter is the first filter in the list to match that packet, the action specified by that filter determines the fate of the packet. The possible filter actions are:

Accept The router lets the packet proceed for further processing.

Drop The router discards the packet.

Reject The router sends an ICMP REJECT (Internet Control Management Protocol) to reject the packet.

Pass to IPSec Two actions - *inipsec and outipsec* - pass the packet to IPSec for further processing. The inipsec action is for packets coming from the other IPSec gateway; it passes the packet to IPSec for decrypting. The *outipsec*action is for packets coming from the local protected network; it passes the packet to IPSec so it can be encrypted and sent to the other IPSec gateway.

Although filters are the mechanism by which packets are passed to IPSec, it is recommended that you use IKE, rather than your own filters, to manage your IP security (see “IPSec (Internet Protocol Security)” on page 5-50).

IP Filter Commands

To define and manage IP filters on an Ethernet interface, use the eth ip filter command. To define and manage IP filters on the remote interface, use the remote ipfilter command.

ICMP Redirect

IP filters of Input type are checked before the IP packet is redirected by ICMP. This could adversely affect local LANs that use ICMP redirect to dynamically learn IP routes. IP filters of Input type are checked before the IP packet is sent to the router itself as a host.

Filter Examples

Example 1: Input Filters Vs. Receive Filters

The following commands add a filter to the beginning of the Input Filters list.

```
-> remote ipfilter insert input drop -p tcp -dp 23 internet
```

When used, the input filter matches any packet for remote interface internet that has protocol TCP and destination port 23. The packets are checked before Network Address Translation, if any; any packets that match the filter are dropped. Thus, this filter stops any attempt by a host coming from the remote internet from sending an IP packet to the Telnet port. The router does not see the packet, and the packet is not forwarded.

Consider, next, the following commands that add a filter identical to the above filter to the beginning of the Receive Filters list:

```
-> remote ipfilter insert receive drop -p tcp -dp 23 internet
```

In the following cases, the Receive filter has the same effect as the Input filter:

- If Network Address Translation is disabled.
- If Network Address Translation is enabled and the Telnet public port is mapped to the Telnet private port by a remote addserver command, such as the following:

```
-> remote addserver 10.0.1.1 tcp telnet internet
```

However, the Receive filter does not have the same effect as the Input filter in the following case:

- If Network Address Translation is enabled and another public port is mapped to the Telnet private port. For example, the following command maps the public port 2000 to the Telnet private port:

```
-> remote addserver 10.0.1.1 tcp 2000 2000 telnet internet
```

In this case, Network Address Translation would translate the packets with port 2000 to the Telnet port and the Receive filter would drop those packets.

For more information, see “Network Address Translation (NAT)” on page 4-17 and the remote addserver command.

Example 2: Filters That Allow Traffic To, But Not Through

Suppose you wanted to allow Telnet packets destined for the router itself, but drop any Telnet packets destined for another interface. This requires two filters. The first filter allows Telnet traffic to the IP address of the router (in this example, 10.0.1.1). The second filter drops all other Telnet traffic.

```
-> remote ipfilter append input accept -p tcp -dp 23 -da
10.0.1.1 internet

-> remote ipfilter append input drop -p tcp -dp 23 internet
```

The filter order is important; packets are compared to filters in the order that the filters appear in the filter list. Any Telnet packet that doesn't match the first filter is dropped by the second filter. Thus, command order is important because each of these commands appends its filter to the end of the list.

Built-in Firewall Filters

Although IP filtering offers great flexibility and control, creating the required series of commands may appear complex to a casual user. Therefore, four sets of firewall filters are resident in the flash memory of factory-built routers.

The four sets of filters offer four levels of security: maximum, medium, minimum, and none. You can select and install any of these filter sets from the Set Firewall page of the Web graphic interface.

The four filter sets are also provided as script files in the samples directory on the Documentation CD. The file names are *maxsec.txt* (maximum security), *medsec*.txt (medium security), *minsec.txt* (minimum security) and *nosec.txt* (no filters). To execute one of these files from the CLI, first copy the file to the router and then use the execute command. For example, to execute the medsec.txt file for medium security, enter:

execute medsec.txt

Before executing any script file, you should check its content. Three of the filter sets are listed at the end of this IP Filtering section ("Example 3: Maximum Security Firewall" on page 5-27, "Example 4: Medium Security Firewall" on page 5-29, and "Example 5: Minimum Security Firewall" on page 5-30). Be sure to edit the file to fit your specific configuration and seek expert help if you are not familiar with security.

Example 3: Maximum Security Firewall

The following lists the filters installed when you request maximum security via the graphic interface.

```
# For DSL routers

# Allow protocols: HTTP, FTP, DNS, L2TP

# Flush all existing filters
remote ipfilter flush input internet
remote ipfilter flush output internet
remote ipfilter flush transmit internet
remote ipfilter flush receive internet
```

```
eth ip filter flush input
eth ip filter flush output
eth ip filter flush transmit
eth ip filter flush receive

# HTTP from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 80 internet
remote ipfilter insert output accept -p tcp -dp 80 internet

# DNS from LAN to WAN will be accepted
remote ipfilter insert input accept -p udp -sp 53 internet
remote ipfilter insert output accept -p udp -dp 53 internet

# FTP from LAN to WAN accepted
remote ipfilter insert input accept -p tcp -sp 20:21 internet
remote ipfilter insert output accept -p tcp -dp 20:21 internet

# FTP WAN TO LAN accepted
remote ipfilter insert input accept -p tcp -dp 20:21 internet
remote ipfilter insert output accept -p tcp -sp 20:21 internet

# L2TP
remote ipfilter insert input accept -p udp -sp 1701 internet
remote ipfilter insert output accept -p udp -dp 1701 internet

# Deny anything not listed above
remote ipfilter append input drop internet
remote ipfilter append output drop internet

# Watch the results
remote ipfilter watch on internet

save
```

Example 4: Medium Security Firewall

The following lists the filters installed when you request medium security via the Web management interface.

```
# For DSL routers

# Flush all existing filters
remote ipfilter flush input internet
remote ipfilter flush output internet
remote ipfilter flush transmit internet
remote ipfilter flush receive internet

eth ip filter flush input
eth ip filter flush output
eth ip filter flush transmit
eth ip filter flush receive

# Allow ICMP replies, requests, and errors from the WAN
remote ipfilter insert input accept -p icmp -sp 0 internet
remote ipfilter insert input accept -p icmp -sp 3 internet
remote ipfilter insert input accept -p icmp -sp 8 internet
remote ipfilter insert input accept -p icmp -sp 11 internet

# Allow ICMP ECHO REPLY, REQUEST to the WAN
remote ipfilter insert output accept -p icmp -sp 0 internet
remote ipfilter insert output accept -p icmp -sp 8 internet

# Telnet from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 23 internet
remote ipfilter insert output accept -p tcp -dp 23 internet

# SSL accepted
remote ipfilter insert input accept -p tcp -sp 443 internet
remote ipfilter insert output accept -p tcp -dp 443 internet

# HTTP from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 80 internet
remote ipfilter insert output accept -p tcp -dp 80 internet

# FTP from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 20:21 internet
remote ipfilter insert output accept -p tcp -dp 20:21 internet

# DNS from LAN to WAN will be accepted
remote ipfilter insert input accept -p udp -sp 53 internet
remote ipfilter insert output accept -p udp -dp 53 internet

# L2TP will be accepted
remote ipfilter insert input accept -p udp -sp 1701 internet
remote ipfilter insert output accept -p udp -dp 1701 internet
```

```
# E-mail - SMTP and POP3 requests from LAN to WAN accepted
remote ipfilter insert input accept -p tcp -sp 25 internet
remote ipfilter insert output accept -p tcp -dp 25 internet
remote ipfilter insert input accept -p tcp -sp 110 internet
remote ipfilter insert output accept -p tcp -dp 110 internet

# Drop all packets
remote ipfilter append input drop internet
remote ipfilter append output drop internet

# Watch the results
remote ipfilter watch on internet

save
```

Example 5: Minimum Security Firewall

The following lists the filters installed when you request minimum security via the Web management interface.

```
# Minimum security script for DSL routers

# For remote commands, input filters apply to traffic from the
WAN, and

# output filters apply to traffic to the WAN.

# Flush all existing filters
remote ipfilter flush input internet
remote ipfilter flush output internet
remote ipfilter flush transmit internet
remote ipfilter flush receive internet

eth ip filter flush input
eth ip filter flush output
eth ip filter flush transmit
eth ip filter flush receive

# Allow ICMP replies, requests, and errors from the WAN
remote ipfilter insert input accept -p icmp -sp 0 internet
remote ipfilter insert input accept -p icmp -sp 3 internet
remote ipfilter insert input accept -p icmp -sp 8 internet
remote ipfilter insert input accept -p icmp -sp 11 internet

# Allow ICMP ECHO REPLY, REQUEST to the WAN
remote ipfilter insert output accept -p icmp -sp 0 internet
remote ipfilter insert output accept -p icmp -sp 8 internet

# Telnet from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 23 internet
remote ipfilter insert output accept -p tcp -dp 23 internet
```

```
# SSL accepted
remote ipfilter insert input accept -p tcp -sp 443 internet
remote ipfilter insert output accept -p tcp -dp 443 internet

# HTTP from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 80 internet
remote ipfilter insert output accept -p tcp -dp 80 internet

# FTP from LAN to WAN will be accepted
remote ipfilter insert input accept -p tcp -sp 20:21 internet
remote ipfilter insert output accept -p tcp -dp 20:21 internet

# DNS from LAN to WAN will be accepted
remote ipfilter insert input accept -p udp -sp 53 internet
remote ipfilter insert output accept -p udp -dp 53 internet

# L2TP will be accepted
remote ipfilter insert input accept -p udp -sp 1701 internet
remote ipfilter insert output accept -p udp -dp 1701 internet

# E-mail - SMTP and POP3 requests from LAN to WAN accepted
remote ipfilter insert input accept -p tcp -sp 25 internet
remote ipfilter insert output accept -p tcp -dp 25 internet
remote ipfilter insert input accept -p tcp -sp 110 internet
remote ipfilter insert output accept -p tcp -dp 110 internet

# Allow SSH from the WAN
remote ipfilter insert input accept -p tcp -dp 22 internet
remote ipfilter insert output accept -p tcp -sp 22 internet

# Allow NETBIOS connections from specific sources on the WAN

# Allow NETBIOS requests from our network
remote ipfilter insert input accept -p tcp -dp 137:139 internet
remote ipfilter insert input accept -p udp -dp 137:139 internet
remote ipfilter insert output accept -p tcp -sp 137:139
internet
remote ipfilter insert output accept -p tcp -dp 137:139
internet
remote ipfilter insert output accept -p udp -dp 137:139
internet

# finger
remote ipfilter insert output accept -p tcp -sp 1024:65535 -dp
79 internet

# POP2 tcp/udp
remote ipfilter insert output accept -p tcp -sp 1024:65535 -dp
109 internet
```

```
# NNTP tcp
remote ipfilter insert output accept -p tcp -sp 1024:65535 -dp
119 internet

# IMAP2 tcp/udp
remote ipfilter insert output accept -p tcp -sp 1024:65535 -dp
143 internet

# certain other non-privileged ports to non-privileged ports
remote ipfilter insert output accept -p tcp -sp 1024:65535 -dp
1024:65535 internet

# Allow NTP, who, Kali, CuSeeMe out to the WAN

# NTP
remote ipfilter insert transmit accept -p udp -dp 123 internet
remote ipfilter insert receive accept -p udp -sp 123 internet

# who
remote ipfilter insert input accept -p udp -sp 513 -dp
1024:65535 internet
remote ipfilter insert output accept -p udp -dp 513 -sp
1024:65535 internet
remote ipfilter insert input accept -b -p udp -sp 2213 -dp
1024:65535 internet
remote ipfilter insert output accept -b -p udp -dp 2213 -sp
1024:65535 internet
remote ipfilter insert input accept -p udp -sp 6666 -dp
1024:65535 internet
remote ipfilter insert output accept -p udp -dp 6666 -sp
1024:65535 internet
remote ipfilter insert input accept -p udp -sp 7648 -dp 7648
internet
remote ipfilter insert output accept -p udp -dp 7648 -sp 7648
internet

# RealAudio
remote ipfilter insert input accept -p udp -dp 7070 internet
remote ipfilter insert output accept -p udp -sp 7070 internet

# traceroute
remote ipfilter insert input accept -p udp -sp 1024:65535 -dp
33434:33500 internet
remote ipfilter insert output accept -p udp -sp 1024:65535 -dp
33434:33500 internet

### Deny any other traffic
remote ipfilter append input drop internet
remote ipfilter append output drop internet
```

```
# Turn on ip filter watch for debugging
remote ipfilter watch on internet

save
```

Stateful Firewall

The Built-in Firewall Filters consist of a set of rules that are examined each time a packet is transmitted or received from the public network. It examines the packet's header information and matches it against a set of defined rules. If it finds a match, the corresponding action is performed. If not, the packet is accepted.

The IP filtering firewalls provide an adequate level of security, but is limited in that it does not look beyond the packet's header to collect more information and may leave the firewall vulnerable to attacks. Also, in some cases, it opens a range of port numbers to allow some protocols to work. For example, the FTP protocol involves an exchange of port number information between the client and server. Here, the client would send the server the port number at which the server can connect to the client. In order for such protocols to work the packet filtering firewalls, a range of ports would have to be opened and exposed since the firewall would not be aware of exactly which port number would be used. This type of static protection leaves machines behind the firewall vulnerable.

The stateful firewall overcomes these limitations by maintaining state information about each session. The firewall intercepts outgoing packets and gathers enough information from them (for example IP address information, port number, etc.) and creates the state information for that session. When an incoming packet is seen, it checks the packet against the state information it has maintained, and if the packet belongs to this session, it is accepted. Thus, by tracking and controlling the flow of information through the firewall, the stateful firewall provides robust security.

Stateful Firewall is a key-enabled feature. The following section applies only to routers with a valid feature key installed. For more information, see "Key Enabled Features" on page 4-29.

Firewall Rules

The rules created by the user are sorted into the 'Allow' and 'Deny' lists. While processing a packet, rules from the Deny list will be applied at first. If the packet matches an entry on this list, it will get dropped. If not, the packet is compared to the Allow rules list. If an entry exists here, the packet is accepted. If not, the packet is dropped.

Rule Creation

This section will discuss creating and modifying firewall rules using the CLI. For rule creation from the WMI, see "Firewall Rule Configuration page" on page 8-63.

When creating a rule, the basic command structure is

firewall <command> <protocol | application> [parameters]

command - This parameter defines the list to which the firewall rule will be assigned. The valid options are:

```
allow | deny
```

For example: **-> firewall allow** -a ftp -sa 192.168.1.34 -d out

protocol | application -The following parameters specify the <protocol> (-p) or <application> (-a) characteristics that a packet must have in order to match the firewall rule. The valid protocol and application parameters are:

Protocol -

```
-p tcp | udp | icmp | <protocol number>
```

The packet must have the specified protocol. For a deny rule, if the protocol matches, it may be dropped (based on additional rule parameters). For an allow rule, if the protocol matches, it may be allowed. When defining a protocol within the rule structure, the protocol or protocol number is preceded by -p.

```
-> firewall allow -p tcp -sa 192.168.1.34 -d out
```

Port Information - When a protocol is specified, port information also may be defined as follows. When port information is entered, the source port value is preceded with -sp and the destination port with -dp.

```
-sp <ICMP type> | <first source port>[:<last source port>]
```

If the protocol is ICMP, the packet must match the specified ICMP type. If the packet is TCP or UDP, if only one source port is specified, the packet must have the specified port, or if a range is defined, a source port that is within the specified port range. If no source port is specified, the firewall rule matches any source port in the range 0 - 65535.

```
-dp <ICMP code> | <first dest port>[:<last dest port>]
```

If the protocol is ICMP, the packet must match the specified ICMP code. If the packet is TCP or UDP, if only one port is specified, the packet must have the specified destination port, or if a range is defined, a port that is within the specified destination port range. If no destination port is specified, the firewall rule matches any destination port in the range 0 - 65535.

```
-> firewall allow -p tcp -sp 161 -sa 192.168.1.34 -d out
```

Application -

```
-a imap | telnet | bootp | nntp | rpc | tftp | smtp |
dns | ftp | rexec | rsh | rlogin | syslog | winframe |
rdp | http | https | ntp | smb | ras | realaudio |
netmeeting | aolim| quicktime | cuseeme | netshow |
pptp | nfs | nis | traceroute | sqlnet | ipsec
```

Packets must match the assigned application characteristics.

```
-> firewall allow -a ftp -sa 192.168.1.34 -d out
```

address - The following <parameters> specify the source and destination IP address information. When entering these parameters on the command line, the `-sa`, `-sm`, `-da` and `-dm` parameters are required before the corresponding parameter values as shown below.

Source address -

```
-sa <first source ip addr>[:<last source ip addr>]
```

The packet must have a source IP address within the specified address range. If only one address is specified, the packet must have that source IP address. If no source IP address is specified, the firewall rule matches any valid IPV4 address.

Source mask -

```
-sm <source ip mask>
```

The firewall rule uses the specified mask when comparing the <first source ip addr>...<last source ip addr> with the source IP address in the IP packet. If no source mask is specified, the mask used is 255.255.255.255.

Destination address -

```
-da <first dest ip addr>[:<last dest ip addr>]
```

The packet must have a destination IP address within the specified address range. If only one address is specified, the packet must have that destination IP address. If no destination IP address is specified, the firewall rule matches any valid IPV4 address.

Destination mask -

```
-dm <dest ip mask>
```

The firewall rule uses the specified mask when comparing the <first dest ip addr>...<last dest ip addr> with the destination IP address in the IP packet. If no destination mask is specified, the mask used is 255.255.255.255.

```
-> firewall allow -a FTP -sa 192.168.1.0 -sm
255.255.255.0 -da 64.12.11.1 -d out
```

message logging - Specify one of these options to determine when watch messages are displayed for this firewall rule. The messages are sent to the console serial port and a Syslog server, if configured. There are two options:

`-q | -v`

Quiet - If `-q` (quiet) is specified, no messages are displayed for this firewall rule, even if the rule causes a packet to be dropped. This is the default setting for firewall *allow* rules.

Verbose - If `-v` (verbose) is specified, a message is displayed every time this firewall rule matches a packet, regardless of the rule action.

```
-> firewall allow -p tcp -sa 192.168.1.34 -q out
```

direction -Specify one of these options to specify the direction of the packet to which the firewall rule is applied. If no direction parameter is specified, the direction is defaulted to `both`. The parameter must be preceded by `-d`.

`in | out`

```
-> firewall allow -p tcp -sa 192.168.1.34 -v -d out
```

Examples

The following examples assume that the machines behind the router are on the subnet 192.168.1.0 with a subnet mask of 255.255.255.0. The router has a WAN address of 12.10.1.1.

- This example will allow the machines behind the router to FTP to any machine on the internet, the firewall rule to be entered for this is:

  ```
  -> firewall allow -a FTP -sa 192.168.1.0 -sm 255.255.255.0 -d out
  ```

- To allow the machines behind the router to FTP to one specific machine, say 64.12.11.1, on the internet, use the command:

  ```
  -> firewall allow -a FTP -sa 192.168.1.0 -sm 255.255.255.0  -da
  64.12.11.1 -d out
  ```

- To allow all the machines behind the router, except, say 192.168.1.20, to FTP to any machine on the internet, you will need to enter two rules - one allow rule and one deny rule. The rules to specify this are:

  ```
  -> firewall deny -a FTP -sa 192.168.1.20 -d out
  ```

  ```
  -> firewall allow -a FTP -sa 192.168.1.0 255.255.255.0 -d out
  ```

- The order in which the rules are evaluated are - Deny rules first and then allow rules. Thus, in this example, when it evaluates the deny rules for an FTP packet going from 192.168.1.20, it would find a matching deny rule and hence the packet would be dropped.

  For packets from any other address in the subnet, the deny rules would not match and so the allow rules would be evaluated next. And since here it would find a match, the packet would be allowed to go through

  ```
  -> firewall allow -a FTP -sa 192.168.1.34 -d out
  ```

- Firewall rules can be used to open up ports that are needed by an application without having to specify all those ports individually. For e.g., netmeeting uses different port numbers. The user does NOT have to open these ports individually. If the use enters an allow rule for that application all the ports used by that application are opened.

  ```
  -> firewall -a netmeeting -sa 192.168.1.23 -d out
  ```

  This opens the ports for machine 192.168.1.23 to use netmeeting.

- If NAT is enabled on the router, then the outgoing firewall rules should be specified in terms of the private addresses. However, for inbound rules, the rules would need to use the router's WAN address. Thus, to allow incoming FTP, the following rule would need to be entered:

  ```
  -> firewall allow -a FTP -da 12.10.1.1 -d in
  ```

Listing Firewall Rules

The following command is used to display the current stateful firewall settings and configured rules. The optional parameters will display only the specified allow or deny rules listing.

```
firewall list [<allow | deny>]
```

Deleting Firewall Rules

The following command is used to delete configured rules. The optional parameters will allow the deletion of a range of rules or all rules from the specified allow or deny rules listing.

```
firewall delete <start rule number> [<end rule number>] <allow
| deny>
```

The delete all command will delete all entries from the allow or deny rules list or both if no parameter is specified.

```
firewall delete all [<allow | deny>]
```

Rule Modification

To modify a previously entered rule, the following command structure is used.

```
-> firewall modify <allow | deny> <number> <parameters>
```

When modifying the rule, it is not necessary to enter the parameters that will not be modified. The firewall rule number can be viewed by using the firewall list command.

For example, to change the source port of the following rule (#16):

```
16. firewall allow -p tcp -sp 161 -da 121.168.2.109 -c 0
-q -d out
```

Only the following parameters are required:

```
-> firewall modify 16 allow -sp 168
```

The following parameters can be used to modify an existing firewall rule:

☞ **NOTE:**

If a firewall rule is modified to deny something that was previously allowed by a firewall allow rule, the change will only apply to subsequent sessions; current sessions will not be effected. When modifying a rule to allow what was previously denied, the changes will be in effect for current sessions.

allow | deny - This parameter defines the list the firewall rule belongs.

number - This is the number corresponding to the rule that needs to be modified.

```
-> firewall modify allow 7 -ac deny
```

parameters - The following paragraphs identify the <parameter>s for modification:

Action - Changes the action taken on the packet when the rule is matched. Rule will move from one allow | deny rules list to the other list. This parameter must be preceded by `-ac`.

```
-ac allow | deny
```

Protocol - Re-defines protocol a packet must have.

```
-p <protocol> | tcp | udp | icmp | <protocol number>
```

Port Information - When port information is entered, the source port value is preceded with `-sp` and the destination port with `-dp`. The parameters are:

```
-sp <ICMP type> | <first source port>[:<last source
port>]
```

Modifies the source port, specified port range, or ICMP type.

```
-dp <ICMP code> | <first dest port>[:<last dest port>]
```

Modifies the destination port, specified port range, or ICMP type.

Application - Modifies the application type packets must match. The valid parameters are:

```
-a imap | telnet | bootp | nntp | rpc | tftp | smtp |
dns | ftp | rexec | rsh | rlogin | syslog | winframe |
rdp | http | https | ntp | smb | ras | realaudio |
netmeeting | aolim| quicktime | cuseeme | netshow |
pptp | nfs | nis | traceroute | sqlnet | ipsec
```

```
-> firewall modify allow -a ftp -sa 192.168.1.34 -d
out
```

Source address - Modifies the specified source address or range of addresses.

```
-sa <first source ip addr>[:<last source ip addr>]
```

Source mask - Modifies the source IP mask. If no source mask is specified, the mask used is 255.255.255.255.

```
-sm <source ip mask>
```

Destination address - Modifies the specified destination address or range of addresses.

```
-da <first dest ip addr>[:<last dest ip addr>]
```

Destination mask - Modifies the destination IP mask. If no destination mask is specified, the mask used is 255.255.255.255.

```
-dm <dest ip mask>
```

Message Logging - Modifies the message logging function.

```
-q | -v
```

Quiet - If `-q` (quiet) is specified, no messages are displayed for this firewall rule, even if the rule causes a packet to be dropped. This is the default setting for firewall *allow* rules.

Verbose - If `-v` (verbose) is specified, a message is displayed every time this firewall rule matches a packet, regardless of the rule action.

```
-> firewall modify 2 allow -q
```

Direction - Modifies the options specifying the direction of the packet to which the firewall rule is applied.

```
in | out
-> firewall modify 7 allow -d out
```

Firewall Status

To following command is used to enable and disables the stateful firewall.

```
-> firewall set on | off
```

☞ **NOTE:**
Firewall rules can be added, deleted, or modified regardless of the firewall status.

To view the current firewall status, use the firewall list command.

☞ **NOTE:**
Firewall rules can be added, deleted, or modified regardless of the firewall status.

Viewing Dropped Packets

This function allows the viewing of the last few dropped packets. The default setting is 200 dropped packets but can be configured for any value up to 200. This information is available from the WMI, “Dropped Packet Page” on page 8-62, or by entering the following command.

```
firewall viewdroppkts <number>
```

The information displayed includes:

- Time and Date
- Protocol
- Source IP address
- Source Port Number / ICMP Type
- Destination IP address
- Destination Port Number / ICMP Code
- Reason for drop

Message Logging

The message logging function configured in the creation of firewall rules can be enabled or disabled on the “Stateful Firewall Configuration Page” on page 8-60 of the WMI or by entering the following command:

```
firewall watch <on | off>
```

When enabled, a message will be printed to the display for an accepted packet only if the verbose (-v) option was specified while creating the rule. If the quiet (-q) option was specified, a message would not be displayed for that rule.

Stateful Firewall and IPSec

The router can act as an IPSec gateway and encrypt outgoing packets using IPSec tunneling. Additionally, IPSec could be implemented on the client machines behind the router, in which case, the router would only need to allow IPSec packets through.

When IPSec is being done at the router, and NAT is enabled, NAT translation is performed on the packet before IPSec acts on it or after IPSec acts on it. To perform NAT before IPSec, use the command:

```
ike ipsec policies set translate on
```

However, if IPSec encryption is to be done before NAT, disable translation with the following command:

```
ike ipsec policies set translate off
```

Denial of Service Attacks

The Stateful Firewall provides for protection against Denial of Service Attacks. In general, there is little a router can do to prevent a Denial of Service (DoS) attack from being launched against it. The router can, however, detect these unsolicited packets and drop them at the earliest possible stage to minimize the amount of CPU and memory usage they consume.

The firewall shall, by default, drop any packet that is not explicitly accepted by the firewall rules, and allow only the services that are explicitly enabled by the security policy. In addition, the firewall will log all the DoS attacks it detects. The following sections provide an overview of this protection.

SYN Attack

SYN attack occurs when the connecting host continuously sends TCP SYN requests without the corresponding ACK response. This flood attack disables a host by sending a stream of SYN packets with a spoofed source IP address. This causes the host to send a SYN/ACK in response to a host that may not exist, or at the very least, will not respond. The host under attack will continue to consume resources while it is responding to these bogus connection attempts until no resources are available. At this point, valid connection attempts will be refused since the host no longer has the ability to respond.

To defend against this type of an attack, the router will maintain a counter to track the number of connection attempts. This counter will be maintained per destination address. If this number exceeds a threshold (*e.g.* 200 per second) then the router will drop any attempt to connect. To re-enable connections, the number of attempts per second needs to fall to an acceptable level.

The threshold value is defined in packets per seconds. To set the threshold value through the WMI, refer to the “Stateful Firewall Configuration Page” on page 8-60, or enter the following command.

```
firewall setsynfloodthreshold <number>
```

ICMP Flood Attack

An ICMP flood attack occurs when ICMP pings are broadcast with the purpose of flooding the system with too much data that it slows down to a point that it times out and is disconnected.

By default, the stateful firewall will filter all incoming ICMP messages, thus, a flood of ICMP echo requests (pings) will be dropped. Should the system administrator enable echo request messages, the router would become vulnerable to this type of attack. Therefore, the firewall maintains a counter for the incoming ICMP echo request packets received per second. When this value exceeds the threshold setting, the firewall shall drop all subsequent ICMP echo requests. As in the SYN flood attack, once the number of echo request has returned to normal, the router will enable receipt of these packets.

The threshold value is defined in packets per seconds. To set the threshold value through the WMI, refer to the “Stateful Firewall Configuration Page” on page 8-60, or enter the following command.

```
firewall seticmpfloodthreshold <number>
```

UDP Flood Attack

Similar to ICMP flood, the User Datagram Protocol (UDP) Flood denial of service attack prays on the chargen service of one router and the echo service of another. By spoofing, the UDP Flood attack hooks up one system's UDP chargen service (which generates a series of characters for each packet it receives) with another system's UDP echo service (which echoes any character it receives in an attempt to test network programs). This results in a nonstop flood of useless data passed between the two systems.

A counter is again maintained that when a threshold has been crossed., will block the UDP echo and chargen ports by default. Look for the UDP packet count exceeding 1000. If the count exceeds 1000, drop subsequent packets until the attack ends.

The threshold value is defined in packets per seconds. To set the threshold value through the WMI, refer to the "Stateful Firewall Configuration Page" on page 8-60, or enter the following command.

```
firewall setudpfloodthreshold <number>
```

Ping of death

TCP/IP specification requires a specific packet size for datagrams being transmitted. Many ping implementations allow users to specify a larger packet than desired, which can trigger a range of adverse system reactions including crashing, freezing and re-booting.

The reassembly implementation currently has a maximum IP packet size of 17000 bytes. Any packets exceeding this size are dropped.

Land Attack

Land attack occurs when spoofing packets are sent with the SYN flag set to a system with any port that is listening. If the packets contain the same destination and source IP address as the sending host, the receiving system hangs or reboots. An anti-spoofing implementation has been augmented to check for the source IP address being equal to the destination IP address and drop any of these packets.

Tiny Packet Attack

Tiny packet attack happens when the payload of an IP packet is single byte. This is an attack against static packet filters. If, for example, the TCP header is fragmented and the filters are checking each fragment prior to reassembly, then the packet filters may not be able to properly check the fields in the header. A filter which by default accepts a packet will allow this bogus packet through. The firewall can impose a minimum packet size for all incoming packets and this minimum should be large enough to contain the transport headers. RFC 1858 describes this attack.

Finger Bomb

In this attack, an intruder can disrupt services by causing excessive processing on the target system. In order to run this attack, the hacker could execute the command:

finger rob@example.com@example.com@example.com……

This causes excessive CPU time by forcing the target server to recursively execute the finger until it reaches the end of the list. The solution is, to disable fingerd support for redirections (for example GNU finger). One can also turn the finger service off (but this not advisable).

Since the router does not implement finger, the router cannot be attacked in this manner. The firewall, by default, filters the finger service.

Fraggle

In this attack, the attacker bombards the victim site with continuous stream UDP echo requests sent to a directed broadcast address. Since the echo request is sent to a broadcast address, all the hosts on the network send back a reply packet. One packet from the attacker can then generate hundreds or thousands of UDP response packets and congest the victim network. The source address is also spoofed in such attacks, so that another victim site gets flooded with these thousands of response packets. By default, the firewall filters any requests to the UDP echo service.

Ping Flood

In this attack, the attacker bombards the victim host with a continuous stream of ICMP echo requests. In a distributed Ping flood attack, the victim host and victim network get flooded with echo ICMP requests from a large number of hosts. Protection form this type of attack is dispensed by the threshold mechanism described in ICMP Flood Attack.

Smurf

In this attack, the attacker bombards the victim site with a continuous stream of ICMP echo requests sent to a directed broadcast address. Since the ping request is sent to a broadcast address, all the hosts on the network send back a reply packet. One packet from the attacker can thus generate hundreds or thousands of ICMP response packets and congest the victim's network. The source address is also spoofed in such attacks, so that another victim site gets flooded with these thousands of response packets. Protection form this type of attack is also handled by the threshold mechanism described in ICMP Flood Attack.

Encryption

Encryption is a key-enabled feature. The following section applies only to routers with the encryption option enabled. For more information, see “Key Enabled Features” on page 4-29. To read about IPSec encryption, see IPSec (Internet Protocol Security).

Two variants of encrypted data links over PPP have been implemented:

- PPP DES (Data Encryption Standard) (RFC 1969)
- Diffie-Hellman

CAUTION:
PPP DES and Diffie-Hellman encryption options may not be exported outside the United States or Canada.

PPP DES (RFC 1969) Encryption

PPP DES (Data Encryption Standard) implementation uses a 56-bit key with fixed transmit and receive keys that are specified in each router. RFC 1969 requires that users must manage the keys. This implementation has been tested for inter-operability with other PPP DES vendors such as IBM and Network Express.

Configuration Commands

To configure PPP DES encryption, add these commands to your standard configuration:

```
-> remote setencryption dese rx <key> <remotename>

-> remote setencryption dese tx <key> <remotename>
```

Observe the following guidelines:

- PPP DES can only be configured using the Command Line Interface (CLI).
- The choice of keys should be carefully considered. Each key must have eight hexadecimal digits. Values that are considered cryptographically weak should be avoided. Consult a security expert for advice.
- Different keys may be used for different remote destinations.
- Use the console port to view error messages and progress. If you see “Unknown protocol” errors, the router receive key and sender Tx key don't match.
- For maximum security, Telnet and SNMP access should be disabled, and PPP CHAP authentication should be used by both ends.

Sample Configuration

Suppose that the routers SOHO (the local router) and HQ (the remote router) described in Chapter 3, Installation and Setup are to be configured to use PPP DES encryption. To add encryption to their configurations, you would enter the following commands:

For router HQ:

```
-> remote setencryption dese rx 1111111111111111 SOHO
-> remote setencryption dese tx 2222222222222222 SOHO
-> save
-> reboot
```

For router SOHO:

```
-> remote setencryption dese tx 1111111111111111 HQ
-> remote setencryption dese rx 2222222222222222 HQ
-> save
-> reboot
```

Remember that the *transmit key* (tx) of *SOHO* is the *receive key* (rx) of *HQ*. Inversely, the *receive key* of *SOHO* is the *transmit key* of *HQ*.

☞ **NOTE:**

The configuration must be saved and the router rebooted (save and reboot commands) for the encryption to be activated.

Diffie-Hellman Encryption

With Diffie-Hellman encryption, each router has an encryption file that is associated with a public key providing 768-bit security. The predefined keys can be replaced by the user. By convention, the key files have the suffix “num” (e.g., dh96.num).

Configuration Commands

To configure Diffie-Hellman encryption, add this command to your standard configuration:

```
-> remote setencryption DESE_1_KEY | DESE_2_KEY [fileName]
<remoteName>
```

Observe the following guidelines:

- Specify DESE_1_KEY if the same key is to be used in both directions. Specify DESE_2_KEY if the keys are to be different. Using the same keys in both directions can significantly reduce the time needed to compute the DES keys from the Diffie-Hellman exchange.
- The optional file name on the command is the name of the file containing the Diffie-Hellman values. If a file is not specified, default values built into the router's kernel are automatically selected. The file format is described later.
- The routers' receive key and sender Tx key must not match.
- Different keys and key files may be used for different remote destinations.
- For maximum security, Telnet and SNMP access should be disabled, and PPP CHAP should be used. Use the console port to view error messages and progress.

Sample Configuration

Suppose that the routers SOHO (the local router) and HQ (the remote router) described in Chapter 3, Installation and Setup are to be configured to use Diffie-Hellman encryption. Also, assume that the same key is to be used in both directions and that the values to be used to generate keys are in the file dh96.num. To add encryption to their configurations, you would enter the following commands:

For router HQ:

```
-> remote setencryption DESE_1_KEY dh96.num SOHO
-> save
-> reboot
```

For router SOHO:

```
-> remote setencryption DESE_1_KEY dh96.num HQ
-> save
-> reboot
```

File Format for the Diffie-Hellman Number File

The default values used to generate keys are listed at the end of this section. If you want to use values other than the defaults, you can create your own Diffie-Hellman number file. The file should follow these rules:

- The file should be 192 bytes, in binary format, consisting of two 96-byte numbers, with the most significant byte in the first position. For example, the number 0x12345678 would appear as 000000...0012345678.
- The first 96 bytes form the modulus. In the equation x' = g^x mod n, n is the modulus. According to Diffie and Hellman, the modulus should be prime, and (n-1)/2 should also be prime.
- The second 96 bytes form the generator, or g in the above equation. The generator should be a primitive root mod n.
- The remaining pieces of the encryption key (x and y) are randomly generated at connection time and change every time the device connects.

☞ **NOTE:**

It is recommend that you consult an encryption expert to obtain cryptographically sound generator and modulus pairs.

Default Modulus:

```
00000000: c9 b4 ed 33 ba 7f 00 9e - ce e0 83 5d a5 4c 19 25
00000010: e0 2d 99 44 e8 8d cd 16 - 02 0e 6c 26 6d 15 7c 95
00000020: 82 9a 8c 2b 19 d0 56 da - 9b 5b a9 cd cf fb 45 2b
00000030: c9 6a 3c 26 e5 b8 1a 25 - 07 b8 07 22 ed 15 8a 56
00000040: 8b f4 30 f2 28 fc 6b f1 - bf a4 3e 87 f0 be d6 1c
00000050: 33 92 b9 5e d1 b7 20 8c - 92 02 cb e5 26 45 02 1d
```

Default Generator:

```
00000000: 90 f0 09 78 cc 23 79 a8 - 6c 23 a8 65 e0 dc 0f 6d
00000010: fb a7 26 e8 63 0a 21 67 - 5a f8 0f 59 84 09 5c da
00000020: ef af af fc d2 5f 83 e2 - a7 27 05 34 17 94 1a 4f
00000030: b2 87 76 97 e7 48 43 db - 62 29 70 9e 7f eb 2c 6e
00000040: 5d 25 1d a1 65 f0 b4 e6 - 47 4d 25 23 0b 20 b9 93
00000050: 27 f0 56 12 5a 97 f6 c5 - 31 b6 19 fc 67 22 93 f5
```

IPSec (Internet Protocol Security)

IPSec security is a key-enabled software option for your router. The following section applies only to routers with the encryption option enabled (see “Key Enabled Features” on page 4-29). Use the key list command to check that IPSec is available on your router.

☞ **NOTE:**

Almost all IPSec capabilities can be selected using the graphic interface. However, a few policy selections are available only through the Command Line Interface described in this section. (The graphic interface is described in the User Reference Guide that came with your router and is also available on the web site www.efficient.com.)

IPSec is an open standard that defines optional authentication and encryption methods at the IP packet level. It is a true network layer protocol that provides authentication, privacy, and data integrity. Its protocol suite is comprised of:

- ESP (Encapsulated Security Payload)—a security protocol that completely encapsulates and optionally encrypts and/or authenticates user data.
- AH (Authentication Header)—a security protocol that authenticates each data packet.
- IKE (Internet Key Exchange)—a security protocol used to establish a shared security policy and authenticated keys before an IPSec data transfer begins.

IPSec sessions are initiated through Security Associations (SAs), which allow peers to negotiate a common set of security attributes. In a nutshell, IPSec assures source authenticity, data integrity and confidentiality of IP packets, providing the level of security required by Virtual Private Networks (VPNs).

IPSec can be used in conjunction with L2TP (see L2TP Tunneling). IPSec offers greater security than L2TP, but it does not support as many network protocols. However, bridged and lower layer protocol traffic may be transmitted across an IPSec network if packets are first encapsulated by L2TP, and then by IPSec.

IPSec does not require modification of individual applications or devices for secure data transport. Although it does require global IP addresses for all peers, Network Address Translation (NAT) may be used with IPSec. (See Network Address Translation.)

Transport and Tunnel Encapsulation Modes

IPSec has two encapsulation modes: transport mode and tunnel mode. Transport mode protects traffic between two nodes or peers (the endpoints of the communication). Tunnel mode protects traffic between peers and/or gateways, such as traffic on a VPN or on any other connection where one or both of the endpoints might not be IPSec systems.

The router supports both IPSec encapsulation methods. It can serve as the endpoint of a tunnel mode connection or as the endpoint of a transport mode connection. Also, while operating in tunnel mode, the router does allow transport mode traffic to flow through it.

Tunnel mode is the default encapsulation mode for the router. It is used when the IPSec packet comes from either another device or from the encrypting device. In tunnel mode, the IP header is encrypted as part of the payload, and an entirely new IP header is added to the packet. Tunnel mode prevents network traffic analysis. A network attacker could determine the tunnel endpoints (the gateway addresses), but not the true source and destination of the tunneled packets, even if they are the same as the tunnel endpoints.

Transport mode is used when the IPSec packet originates in the encrypting device. In transport mode, only the payload (data portion) of each IP packet is encapsulated and/or encrypted. An IPSec header is inserted between the IP header and the upper layer protocol header.

The router should be configured for transport mode when a client is communicating directly with the router. For example, use transport mode when a remote user wants to access the HTML setup pages or Telnet into the router. It can also be used for L2TP over IPSec. The routers at either end of the L2TP tunnel do both the IPSec and L2TP encapsulations so the routers can use Tunnel and Transport mode for communications.

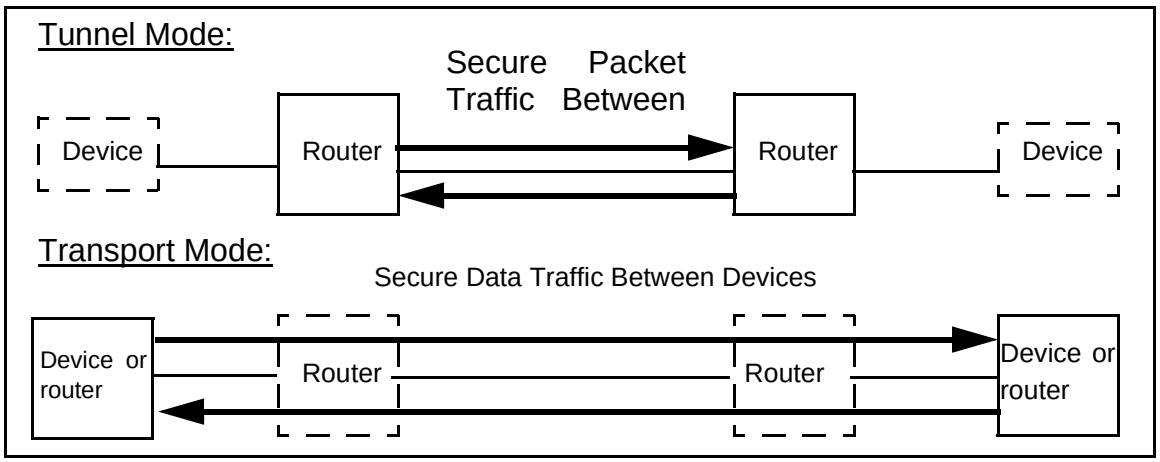


Figure 5-4: Tunnel and Transport Encapsulation Modes

ESP and AH Security Protocols

An IPSec connection must use either the AH or the ESP security protocol.The protocol selected determines the encapsulation method used. In addition, the protocol also determines whether encryption may be performed. If the AH protocol is selected, only packet authentication can be performed, not encryption. If the ESP protocol is selected, it can perform encryption, authentication, or both encryption and authentication.

If ESP encryption is selected, ESP automatically encrypts the data portion (payload) of each packet using the chosen encryption method, DES (56-bit keys) or 3DES (168-bit keys).

CAUTION:
Restrictions may exist on the export of the DES and 3DES encryption options outside the United States or Canada.

Although encryption cannot be specified for individual applications, a server could be partitioned to achieve the same effect. Given that packets can be encrypted using any combination of security association (SA), protocol, source port, and destination port, you could specify that traffic to and from one database be encrypted while allowing unencrypted traffic to pass freely to and from other databases on the server.

Both the ESP and AH protocols support authentication and replay detection. Replay detection uses sequence numbers to reject old or duplicate packets. The packet is authenticated using a message digest derived from either of two hashing algorithms—SHA-1 (Secure Hashing Algorithm 1) or MD5 (Message Digest 5).

The ESP protocol can authenticate the data origin and data integrity; it does not authenticate the entire packet. More specifically, the message digest is inserted following, not before, the payload. Both the message digest and payload are sandwiched between the ESP header and ESP trailer.

The AH protocol can perform packet authentication. The AH header protocol defines authentication methods for both the packet's outer IP header and its payload. Unlike ESP authentication, the message digest is inserted in front of the payload.

Figure 5-5 shows the transformed IP packet after the ESP or AH protocol has been applied in tunnel mode.

IKE Management

Internet Key Exchange (IKE) management makes encryption key exchange practical, even in large networks where there are many unknown intermediate links between sending and receiving nodes. Unlike protocols that allow only one key exchange per session, IKE can generate and transfer multiple keys between peers during a single tunnel session. Users may specify the duration for which keys are valid. This dynamic type of Diffie-Hellman key exchange greatly reduces the chances of a network attacker finding an entry into a tunnel.

If you wish, you may also select Perfect Forward Secrecy (PFS) to increase the security of the key exchange. PFS ensures that the compromise of a single key permits access to only data protected by that particular key. However, PFS requires use of a Diffie-Hellman group for each re-key, adding overhead to the process and causing IKE to run more slowly. Thus, PFS is not always desirable.

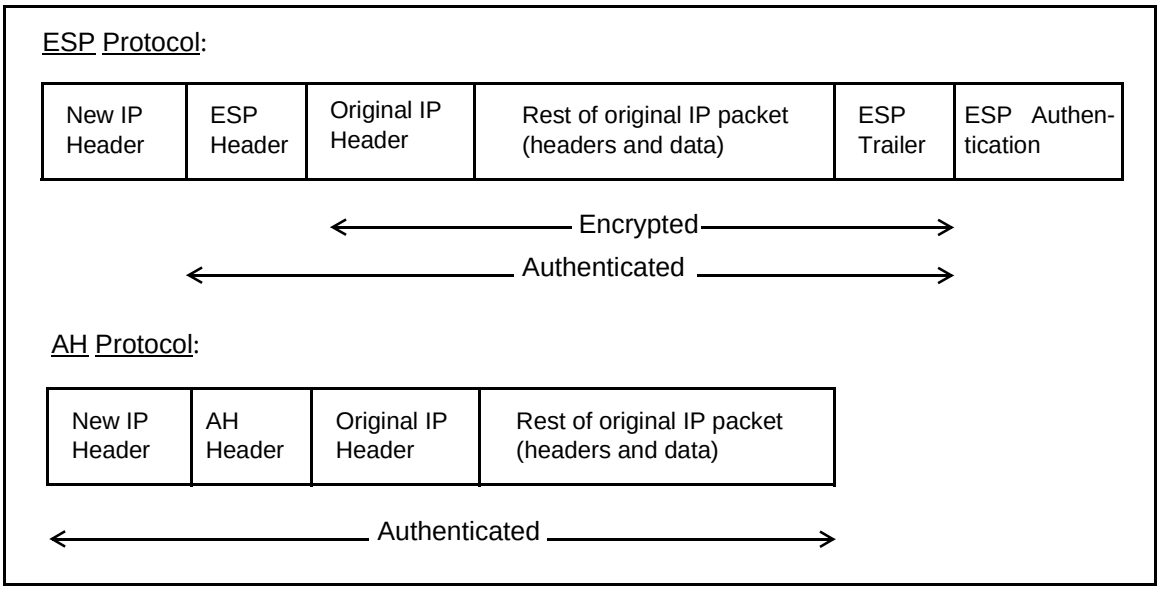


Figure 5-5: ESP and AH Security

Because VPN users are likely to be using a variety of protocols, a common set of security attributes must be negotiated at the beginning of any tunnel session. Phase 1 IKE is responsible for negotiating these security attributes and establishing peer identities. A secure tunnel for the exchange of encryption keys is also created during this phase. Phase 2 IKE then exchanges proposals for IPSec security attributes, generates the encryption keys and sets up IPSec Security Associations (SAs) for moving user data.

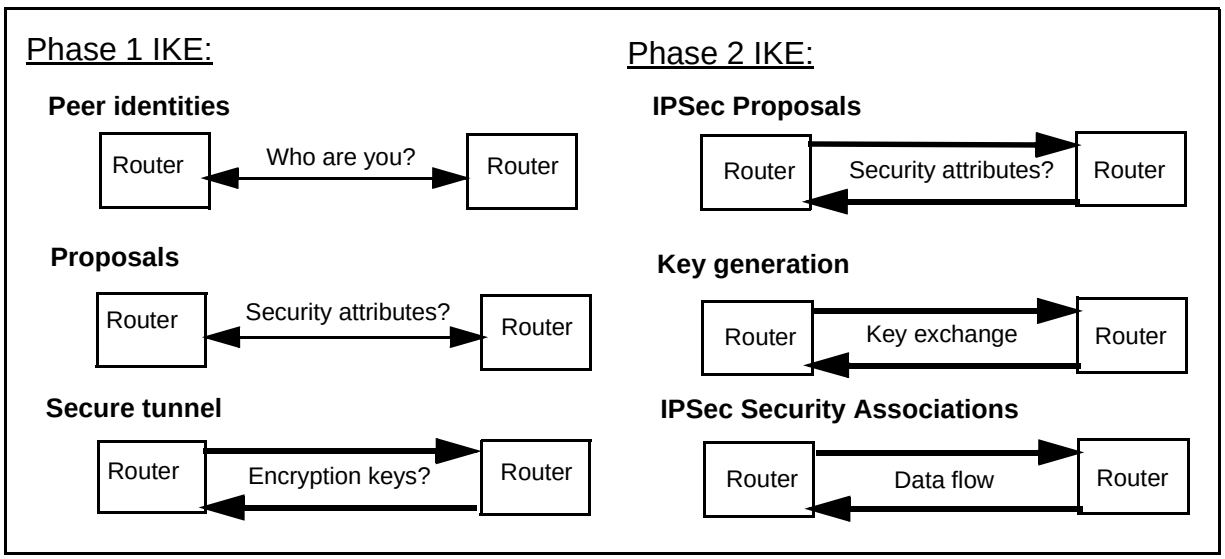


Figure 5-6: IKE Management

Main Mode and Aggressive Mode

The router supports two Phase 1 IKE modes: main mode and aggressive mode. These modes apply only to the Phase 1 negotiations, not to the ensuing data transmission.

Main mode is used when both source and destination IP addresses are known. In main mode, only two options require definition initially—the remote peer IP address and the shared secret.

Aggressive mode is used when either the source or destination IP address could change, as with a remote modem or DSL connection. In aggressive mode, additional information must be specified at the beginning of a session. This additional information includes the remote gateway's IP address, the local and remote peer IDs, and an ID type. This information is checked against the router's Security Association (SA) database. If a match is found, a tunnel session can be established.

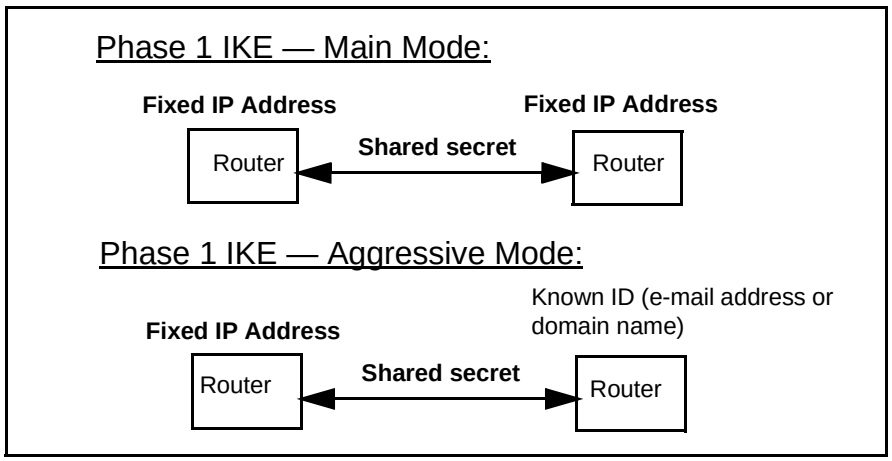


Figure 5-7: IKE Modes

Additional IKE Settings

In addition to the peer identification and shared secret described earlier, IKE requires that the router be configured with the following information:

- Session authentication
- Phase 1 IKE message authentication
- Phase 1 IKE message encryption
- One of the following for each IKE proposal:
  - IPSec AH packet authentication
  - IPSec ESP data authentication
  - IPSec ESP data encryption
  - IPSec ESP data authentication and data encryption
- Diffie-Hellman key generation group
- IPSec policy (filter) setup
- Policy and peer associations
- Policy and proposal associations

Security Associations (SAs)

A Security Association (SA) is an instance of security policy and keying material applied to a data flow. Both IKE and IPSec use SAs. An IPSec SA is unidirectional, applying to only one direction of data flow. An IKE SA is bi-directional, and thus, only one IKE SA is needed for a secure connection.

After an IKE SA is established, any number of IPSec SAs may be created. Although IPSec SAs can be configured manually, most networks rely on IKE to set them up. IKE negotiates and establishes SAs on behalf of IPSec. SAs are negotiated between the two endpoints of the tunnel and contain information on sequence numbering for anti-replay.

IPSec SAs are unidirectional so a set of SAs is needed for a secure connection. For each security protocol used, one SA is needed for each direction (inbound and outbound). Usually, only one protocol (ESP or AH) is used so the connection would use two SAs (one inbound and one outbound). However, it is possible for a connection to use four SAs if it uses two proposals and policies, one requiring the ESP protocol and the other requiring the AH protocol.

IKE negotiates SAs in the following sequence:

Phase 1 IKE:

The session initiator creates a cookie and sends it to the responder, with a zero placeholder in the responder cookie area. The responder then creates a cookie and fills in the zeros. All packets will contain these two cookies until the Phase 1 SA expires. IKE Peer commands next establish the identity of local and remote peers. Then IKE Proposal commands specify how packets will be encrypted and/or authenticated for the initial exchange.

Phase 2 IKE:

IKE IPSec Proposal commands specify *how* packets will be encrypted/authenticated for the final SA. Then IKE IPSec Policy commands specify *which* packets will be encrypted/authenticated for the final SA.

IKE Commands

The Internet Key Exchange (IKE) process consists of two phases. In phase 1, a moderately secure connection is established between the two security endpoints. This connection is used to exchange key and connection information for the final security association (SA), which is used to exchange user data.

Use the following command to clear all IKE configuration information from the router.

```
-> ike flush
```

The other IKE commands relate to the four categories of information required to set up IKE in the router.

1. IKE Proposal Commands establish the identity of the local and remote peers.
2. IKE Proposal Commands define the proposals exchanged during the Phase 1 exchange.
3. IKE IPSec Proposal Commands specify the parameters for the final SA.
4. IKE IPSec Policy Commands specify the filtering parameters for the final SA.

IKE Peer Commands

The IKE peer commands establish the identity of the local and remote peers.

```
-> ike peers add <peername>
```

Defines the name of a new IKE peer.

```
-> ike peers delete <peername>
```

Deletes an existing IKE peer.

```
-> ike peers list
```

Lists the IKE peers.

The following commands define the peer connection.

```
-> ike peers set mode <main | aggressive> <peername>
```

Sets the peer connection to either main or aggressive mode. Main mode is used when the IP addresses of both ends are known. Aggressive mode is used when the address of one end can change, as with a typical modem or DSL connection.

For a main mode connection, set only the IP address and the secret:

```
-> ike peers set address <ipaddress> <peername>
```

Sets the IP address of the other endpoint. In a main mode configuration, the other endpoint is constant.

```
-> ike peers set secret <secret> <peername>
```

Sets the shared secret for the peer. The secret must be identical for both ends. It can be up to 256 characters long; do not use spaces or non-printable characters.

For an aggressive mode connection, you must set the IP address and secret and several more options.

```
-> ike peers set address <ipaddress> <peername>
```

Sets the IP address of the other endpoint. One end, the gateway, has a fixed IP address. The other end, the client, has a changing address. When configuring the client, set the peer IP address to the gateway's fixed address. When configuring the gateway for aggressive mode, set the IP address to 0.0.0.0.

```
-> ike peers set secret <secret> <peerpame>
```

Sets the shared secret for the peer. The secret must be identical for both ends.It can be up to 256 characters long; do not use spaces or non-printable characters.

```
-> ike peers set localidtype <IPADDR | DOMAINNAME | EMAIL>
<peerpame>
```

Sets the type of the local ID (IP address, domain name, or e-mail address). This must match the peer ID type on the other end.

```
-> ike peers set localid <aggressivemodeid> <peername>
```

Sets the local ID. This must match the peer ID on the other end.

```
-> ike peers set peerid <aggressivemodeid> <peername>
```

Sets the peer ID. This must match the local ID on the other end.

```
-> ike peers set peeridtype <ipaddr | domainname | email>
<peername>
```

Sets the type of the peer ID (IP address, domain name, or e-mail address).This must match the local ID type on the other end.

IKE Proposal Commands

The IKE proposal commands define the proposals exchanged during the Phase 1 SA.

```
-> ike proposals add <proposalname>
```

Defines the name of a new IKE proposal.

```
-> ike proposals delete <proposalname>
```

Deletes an existing IKE proposal.

```
-> ike proposals list
```

Lists the IKE proposals.

The following commands specify the contents of the proposals exchanged.

```
-> ike proposals set session_auth <preshare> <proposalname>
```

Proposes the session authentication; preshared key is currently the only option.

```
-> ike proposals set encryption <des | 3des> <proposalname>
```

Proposes the encryption method used, as follows:

- DES Encryption using a 56-bit key.
- 3DES Encryption using three 56-bit keys, thus, producing 168-bit encryption.

```
-> ike proposals set message_auth <none | md5 | sha1>
<proposalname>
```

Proposes the message authentication performed. It can propose no message authentication or authentication using the hash algorithm Message Digest 5 (MD5) or Secure Hash Algorithm-1 (SHA1).

```
-> ike proposals set dh_group <none | 1 | 2> <proposalname>
```

Proposes the Diffie-Hellman (DH) key generation group used (no group or group 1 or 2).

```
-> ike proposals set lifetime <seconds> <proposalname>
```

Proposes the length of time (in seconds) before the Phase 1 SA expires; the recommended value is 86400 (24 hours). When the time limit expires, IKE renegotiates the connection.

IKE IPSec Proposal Commands

The IKE IPSec proposal commands define the proposals exchanged to set up an IPSec SA, that is, an SA for the user data transfer.

```
-> ike ipsec proposals add <proposalname>
```

Defines the name of a new IKE IPSec proposal.

```
-> ike ipsec proposals add <proposalname>
```

Defines the name of a new IKE IPSec proposal.

```
-> ike ipsec proposals delete <proposalname>
```

Deletes an existing IKE IPSec proposal.

```
-> ike ipsec proposals list
```

Lists the IKE IPSec proposals.

The followings proposals set commands specify the contents of the proposals exchanged.

☞ **NOTE:**

The next three commands (set espenc, set espauth, and set ahauth) determine the encapsulation method (AH or ESP) used and the authentication and/or encryption requested by the proposal.

You cannot request both AH and ESP encapsulation in the same proposal. (It is possible for a connection to use two proposals, one that requests AH and the other that requests ESP.)

In any one proposal, you can request any one of the following:

- AH authentication
- ESP encryption
- ESP authentication
- ESP encryption and authentication

```
-> ike ipsec proposals set espenc <des | 3des | null | none>
<proposalname>
```

Determines whether ESP encryption is requested and, if it is requested, the encryption method used.

- DES - Use ESP encapsulation and 56-bit encryption
- 3DES - Use ESP encapsulation and 168-bit encryption (if 3DES is enabled in the router; see Software Option Keys.)
- NULL - No encryption, but use ESP encapsulation. Headers are inserted as though the data was encrypted. This allows verification of the source, but sends the data in the clear, increasing throughput.
- NONE - No encryption and no ESP encapsulation. (If you select this option, the encapsulation method must be requested by a set espauth or set ahauth command.)

-> ike ipsec proposals set espauth <*md5* | *sha1* | *none*> <*proposalname*>

Determines whether ESP message authentication is requested and, if it is requested, the hash algorithm used.

- MD5 - Use ESP encapsulation and authenticate using hash algorithm Message Digest 5.
- SHA1 - Use ESP encapsulation and authenticate using hash algorithm Secure Hash Algorithm-1.
- NONE - No ESP encapsulation and no ESP message authentication. (If you select this option, the encapsulation method must be requested by a set espenc or set ahauth command.)

-> ike ipsec proposals set ahauth <*md5* | *sha1* | *none*> <*proposalname*>

Determines whether AH message authentication is requested and, if it is requested, the hash algorithm used.

-> ike ipsec proposals set espauth <*md5* | *sha1* | *none*> <*proposalname*>

Determines whether ESP message authentication is requested and, if it is requested, the hash algorithm used.

☞ **NOTE:**

The proposal cannot request both AH encapsulation and ESP encapsulation.

- MD5 - Use AH encapsulation and authenticate using hash algorithm Message Digest 5.
- SHA1 - Use AH encapsulation and authenticate using hash algorithm Secure Hash Algorithm-1.
- NONE - No AH encapsulation and no AH message authentication. (If you select this option, the encapsulation method must be requested by a set espenc or set espauth command.)

-> ike ipsec proposals set ipcomp <*none* | *lzs*> <*proposalname*>

Proposes either no compression or LZS compression.

-> ike ipsec proposals set lifetime <*seconds*> <*proposalname*>

Proposes the length of time (in seconds) before the IPSec SA expires; the recommended value is 86400 (24 hours). When the time limit expires, IKE renegotiates the connection.

-> ike ipsec proposals set lifedata <*kbytes*> <*proposalname*>

Proposes the maximum number of kilobytes for the IPSec SA; 0 means unlimited. After the maximum data is transferred, IKE renegotiates the connection. By limiting the amount of data that can be transferred, you reduce the likelihood of the key being broken.

IKE IPSec Policy Commands

The IKE IPSec policy commands specify the filtering parameters for the IPSec SA.

```
-> ike ipsec policies add <policyname>
```

Defines the name of a new IPsec policy.

```
-> ike ipsec policies delete <policyname>
```

Deletes an existing IPSec policy.

```
-> ike ipsec policies list
```

Lists the IPSec policies.

```
-> ike ipsec policies enable <policyname>
```

Indicates that the specification of this IPSec policy is complete and enables use of the policy.

```
-> ike ipsec policies disable <policyname>
```

Disables an IPSec policy.

The following commands define the filtering parameters for the policy.

```
-> ike ipsec policies set peer <peername> <policyname>
```

Specifies an IKE peer that may be used for the connection.

```
-> ike ipsec policies set mode <tunnel | transport>
<policyname>
```

Specifies the encapsulation mode (tunnel or transport) that may be used for the connection. The default is tunnel mode.

```
-> ike ipsec policies set proposal <proposalname> <policyname>
```

Specifies an IKE IPSec proposal that may be used for the connection. (It must have been defined by IKE IPSec proposal commands.) The policy may allow more than one value for the proposal parameter. For example, two set proposal commands could specify two proposals, either of which could be used by the connection.

```
-> ike ipsec policies set pfs <none | 1 | 2> <policyname>
```

Sets the Perfect Forward Secrecy negotiation and specifies the Diffie-Hellman group used for each rekey (none or group 1 or 2). Perfect Forward Secrecy increases the security of the key exchange; compromise of a single key permits access to only the data protected by that particular key. However, the additional encryption slows the IKE process so it is not always desirable.

```
-> ike ipsec policies set source <ipaddress> <ipmask> <policyname>
```

Requires that the data come from the specified source IP address and mask.

```
-> ike ipsec policies set dest <ipaddress> <ipmask> <policyname>
```

Requires that the data be intended for the specified destination IP address and mask.

```
-> ike ipsec policies set translate on | off  <policyname>
```

Determines whether the router applies NAT (network address translation) before the packets are encrypted by IPSec. If translate is set to on, the packets are sent using the host router's public IP address. The remote must have IP address translation enabled (see "Network Address Translation (NAT)" on page 4-17.). The address that NAT translates to should be the source or destination address for the policy (use the set source or set dest commands).

```
-> ike ipsec policies set protocol <protocol | tcp | udp | *>
<policyname>
```

Requires a specific protocol that must be used or allows any protocol (*).

```
-> ike ipsec policies set sourceport <portnumber | telnet |
http | smtp | tftp | *> <policyname>
```

Requires a specific source port for the data or allows any source port (*) (Because port numbers are TCP and UDP specific, a port filter is effective only when the protocol filter is TCP or UDP.)

```
-> ike ipsec policies set destport <portnumber | telnet | http
| smtp | tftp | *> <policyname>
```

Requires a specific destination port for the data or allows any destination port (*). (Because port numbers are TCP and UDP specific, a port filter is effective only when the protocol filter is TCP or UDP.)

```
-> ike ipsec policies set interface <interface> <policyname>
```

Requires a specific interface that must be used or allows all interfaces (all). The policy is only used when the specified interface is connected. The specified interface must be the interface to the IKE peer.

IKE Configuration Examples

This section shows two simple IKE configurations. The installation CD also contains sample configuration files. These files can be edited for your installation and copied to the router using TFTP or the Windows Quick Start application. For more information on TFTP use, see Batch File Command Execution xxx.

The first example in this section shows an IKE configuration that uses main mode for a secure connection between two routers with fixed IP addresses. The second example shows how the first configuration must change when one of the routers no longer has a fixed IP address thus, requiring aggressive mode.

Main Mode Example

The following example lists two setup files that configure two routers for an IKE main mode connection. The two routers are referred to as the home office router and the branch office router.

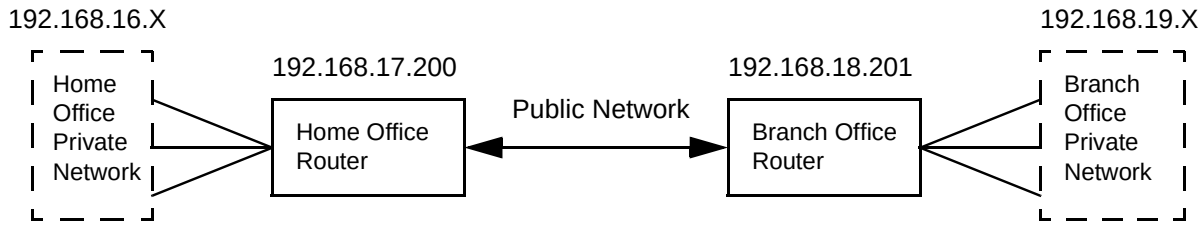


Figure 5-8: Main Mode Example

The configuration sets up a secure connection between the two routers across a public network, thus, the routers are identified by their public IP addresses on the ike peers commands. The packets that are transmitted through this secure connection are from devices in the home office and branch office networks. These networks use private addresses, and thus the packets contain private IP addresses. The ike ipsec policies commands specify these private source and destination addresses.

This is the file for the home office router:

```
# Home office example using IKE
# Home router private network addresses are 192.168.16.X
# Home router public address is 192.168.17.200
# Branch router private network addresses are 192.168.19.X
# Branch router public address is 192.168.18.201

# Describe the branch office peer

# IKE main mode is used because the branch office has a fixed IP
address

# (192.168.18.201). The shared secret is ″ThisIsASecret12345;)″

ike peers add branch_peer
ike peers set mode main branch_peer
ike peers set address 192.168.18.201 branch_peer
ike peers set secret ThisIsASecret12345;) branch_peer
```

```
# Describe the branch office IKE phase 1 connection
# DES encryption
# MD5 authentication
# Diffie-Hellman group 2 key exchange
# 24-hour timeout
# Unlimited data

ike proposals add branch_proposal
ike proposals set encryption des branch_proposal
ike proposals set message_auth md5 branch_proposal
ike proposals set dh_group 2 branch_proposal
ike proposals set lifetime 86400 branch_proposal

# Describe the desired IPSec connection
# Triple-DES encryption
# SHA1 authentication
# 30-minute timeout
# Unlimited data

ike ipsec proposals add branch_ipsec_prop
ike ipsec proposals set espenc 3des branch_ipsec_prop
ike ipsec proposals set espauth sha1 branch_ipsec_prop
ike ipsec proposals set lifetime 1800 branch_ipsec_prop
ike ipsec proposals set lifedata 0 branch_ipsec_prop

# Describe the packets to be encrypted
# All packets from network 192.168.19.0/24 to network
192.168.16.0/24
ike ipsec policies add branch_policy
ike ipsec policies set source 192.168.16.0 255.255.255.0
branch_policy
ike ipsec policies set dest 192.168.19.0 255.255.255.0
branch_policy
ike ipsec policies set peer branch_peer branch_policy
ike ipsec policies set proposal branch_ipsec_prop branch_policy

# Enable the IKE connection

ike ipsec policies enable branch_policy

# Save the setup and reboot

save
reboot
```

This is the file for the branch office router:

```
# Branch office example using IKE
# Home router private network addresses are 192.168.16.X
# Home router public address is 192.168.17.200
# Branch router private network addresses are 192.168.19.X
# Branch router public address is 192.168.18.201

# Describe the home office peer
# IKE main mode is used because the home office has a fixed IP
address

# (192.168.17.200). The shared secret is ″ThisIsASecret12345;)″

ike peers add home_peer
ike peers set mode main home_peer
ike peers set address 192.168.17.200 home_peer
ike peers set secret ThisIsASecret12345;) home_peer

# Describe the home office IKE phase 1 connection
# DES encryption
# MD5 authentication
# Diffie-Hellman group 2 key exchange
# 24-hour timeout
# Unlimited data

ike proposals add home_proposal
ike proposals set encryption des home_proposal
ike proposals set message_auth md5 home_proposal
ike proposals set dh_group 2 home_proposal
ike proposals set lifetime 86400 home_proposal

# Describe the desired IPSec connection
# Triple-DES encryption
# SHA1 authentication
# 30-minute timeout
# Unlimited data

ike ipsec proposals add home_ipsec_prop
ike ipsec proposals set espenc 3des home_ipsec_prop
ike ipsec proposals set espauth sha1 home_ipsec_prop
ike ipsec proposals set lifetime 1800 home_ipsec_prop
ike ipsec proposals set lifedata 0 home_ipsec_prop

# Describe the packets to be encrypted
# All packets from network 192.168.16.0/24 to network
192.168.19.0/24
```

```
ike ipsec policies add home_policy
ike ipsec policies set source 192.168.19.0 255.255.255.0
home_policy
ike ipsec policies set dest 192.168.16.0 255.255.255.0
home_policy
ike ipsec policies set peer home_peer home_policy
ike ipsec policies set proposal home_ipsec_prop home_policy

# Enable the IKE connection

ike ipsec policies enable home_policy

# Save the setup and reboot

save
reboot
```

Aggressive Mode Example

This example supposes, like the preceding main mode example, that a secure connection is needed between a home office router and a branch office router. However, now the DSL connection for the branch office router does not provide a fixed IP address for the branch office router. Thus, an aggressive mode IKE configuration is required.

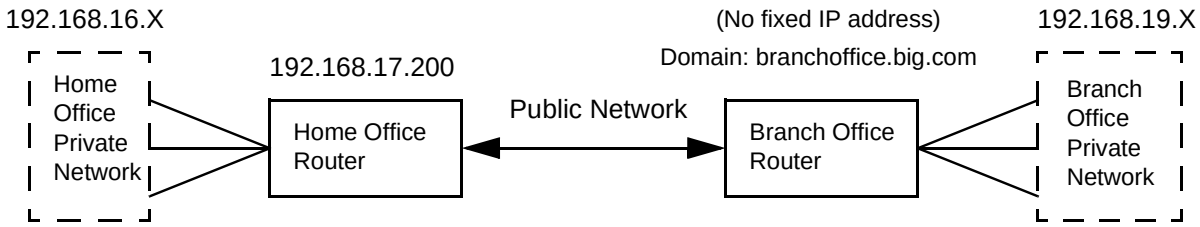


Figure 5-9: Aggressive Mode Example

To change the main mode configuration to an aggressive mode configuration, you only need to change the ike peers commands. All the other IKE commands remain the same. Change the mode to aggressive and change the address of the router that has no fixed address to 0.0.0.0, and specify either its e-mail address or domain name.

☞ **NOTE:**

Remember to save and reboot each router after entering the configuration changes.

Change the ike peers commands in the home office router configuration to the following:

```
#Describe the branch office peer
#IKE aggressive mode is required because the branch office does
not have a fixed IP address.

#The shared secret is “ThisIsASecret12345;)”

ike peers add branch_peer
ike peers set mode aggressive branch_peer
ike peers set address 0.0.0.0 branch_peer
ike peers set secret ThisIsASecret12345;) branch_peer
ike peers set peeridtype domainname branch_peer
ike peers set peerid branchoffice.big.com branch_peer
ike peers set localidtype ipaddr branch_peer
ike peers set localid 192.168.17.200 branch_peer
```

Change the ike peers commands in the branch office router configuration to the following:

```
#Describe the home office peer
#IKE aggressive mode is required because the branch office does
not have a fixed IP address.

#The shared secret is “ThisIsASecret12345;)”

ike peers add home_peer
ike peers set mode aggressive home_peer
ike peers set address 192.168.17.200 home_peer
ike peers set secret ThisIsASecret12345;) home_peer
ike peers set peeridtype ipaddr home_peer
ike peers set peerid 192.168.17.200 home_peer
ike peers set localidtype domainname home_peer
ike peers set localid branchoffice.big.com home_peer
```

IPSec Commands

The following commands allow you to define an IPSec connection without IKE.

☞ **NOTE:**
If you define a tunnel using IPSec commands, the keys will remain static. This could pose a security risk and is not recommended. Use of IKE for key management is recommended.

-> ipsec flush

Clears all IPSec definitions.

-> ipsec add <*saname*>

Defines an SA name.

-> ipsec delete <*saname*>

Deletes an existing SA name.

-> ipsec list [<*saname*>]

Lists one or all SA entries.

-> ipsec enable <*saname*>

Enables a defined SA name.

-> ipsec disable <*saname*>

Disables a defined SA name.

The following commands define parameters for the specified Security Association (SA).

-> ipsec set mode <*tunnel* | *transport*> <*saname*>

Requests the encapsulation mode (tunnel or transport) for the SA. The default is tunnel mode.

-> ipsec set direction <*inbound* | *outbound*> <*saname*>

Defines the direction of the SA.

-> ipsec set gateway <*ipaddress*> <*saname*>

Defines the IP address of the gateway.

-> ipsec set encryption <*null* | *des-cbc* | *3des*> <*saname*>

Selects no encryption, DES (56-bit) encryption or 3DES (168-bit) encryption.

```
-> ipsec set authentication <sha1 | md5> <saname>
```

Selects authentication using either SHA-1 (Secure Hashing Algorithm 1) or MD5 (Message Digest 5)

```
-> ipsec set enckey <key> <saname>
```

Specifies the encryption key (in hexadecimal, 64 bits for DES or 192 bits for 3DES).

```
-> ipsec set authkey <key> <saname>
```

Specifies the authentication key (hexadecimal).

```
-> ipsec set ident <ident> <saname>
```

Specifies the identifier (SPID) for the IPSec tunnel. It must match the SPID at the other end of the tunnel, that is, the tx SPID on this end must match the rx SPID on the other end.

```
-> ipsec set service <esp | ah | both> <saname>
```

Selects the authentication and/or encryption services used: AH authentication, ESP encryption, or both ESP encryption and ESP authentication (encryption applied first and then authentication).

```
-> ipsec set compression <none | lzs> <saname>
```

Selects either LZS compression or no compression.

SSH

Secure Shell (SSH) is a key-enabled feature that allows secure network services over an insecure network such as the public Internet. The objective of SSH is to make a secure functional equivalent for telnet. Telnet connections and command are vulnerable to a variety of different kinds of attacks, allowing unauthorized system access, and even allowing interception and logging of traffic to and from the system including passwords. SSH also provides secure FTP type file transfer.

SSH protects against:

- IP spoofing, where a remote hosts sends out packets which pretend to come from another, trusted host. SSH also protects against spoofing on the local network when attempting to deceive, posing as the router to the outside.
- IP source routing, where a host can pretend that an IP packet comes from another, trusted host.
- DNS spoofing, where an attacker forges name server records.
- Interception of clear text passwords and other data by intermediate hosts.
- Manipulation of data by users in control of intermediate hosts.

SSH Protocol

SSH is available in two versions, SSH1 and SSH2. The two version are not compatible as the differ in their networking implementation, authentication, and encryption. Currently, the router supports only SSH version 2.

Operating under SSH Version 2, each host has a host-specific key (RSA or DSA) used to identify that host. The key is used to authenticate that the client is actually connecting to the server and not being intercepted by an intermediary. This forward security is provided through a Diffie-Hellman key agreement. This key agreement results in a shared session key.

The rest of the session is encrypted using a symmetric cipher. The client selects the encryption algorithm to use from those offered by the server; Arcfour, Twofish, Blowfish, DES, or 3DES (the default setting). Additionally, session integrity is provided through a cryptographic message authentication code either SHA-1 or MD-5 (the default setting).

Another perspective of the SSH protocol illustrates that it consists of three major components:

- Transport Layer Protocol - The transport layer protocol provides server authentication, confidentiality, and integrity. The transport layer is typically run over a TCP/IP connection, but may also be used on top of any other reliable data stream. This phase is also known as the Protocol Identification phase. The negotiation messages between the client and server are shown in Figure 5-10.

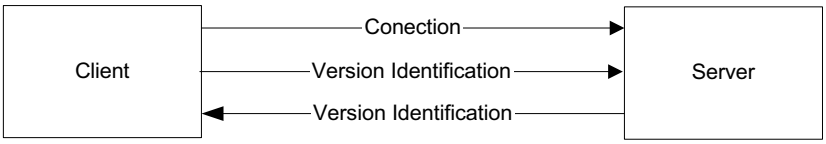


Figure 5-10: Protocol Identification Phase

Note: *A connection is always initiated by the client side.*

- User Authentication Protocol - The user authentication protocol authenticates the client-side user to the server. This authentication phase runs over the transport layer protocol. This phase's negotiation messages are shown in Figure 5-11. In this phase, both ends of the connection enable encryption using the selected keys and encryption method.

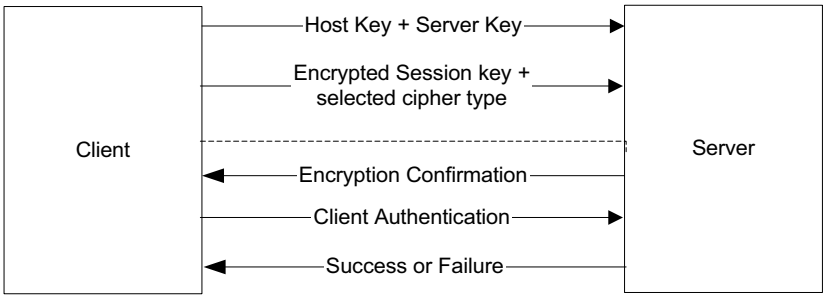


Figure 5-11: Authentication Phase

- The Connection protocol multiplexes the encrypted tunnel into several logical channels. This protocol runs over the user authentication protocol and is also known as the Session Presentation phase. The negotiation messages between the client and server for this phase are shown in Figure 5-12. Currently, only 1 channel per tunnel is supported with a maximum of five tunnels.

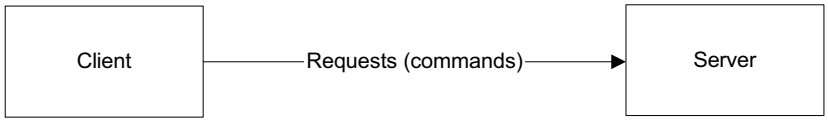


Figure 5-12: Session Presentation Phase

Once the secure session has been established, the user (on the client end) must still provide a username and password for further authentication. If the user has the proper privileges, access to the authorized management facilities are granted. For example, if a user has established a secure (SSH) connection across the WAN, access may still be denied if their user account is set to LAN access only privilege. For more information on user privileges, see "User Authentication" on page 5-2.

Key Exchange

Diffie-Hellman is the key exchange system used for authentication in the establishment and maintenance of SSH connections. Diffie-Hellman is an algorithm by which two factions can agree on a shared secret key, known only to them. The secret is negotiated over an insecure network without the two parties ever passing the actual shared secret, or their private keys, between them.

A synopsis of the algorithm is as follows: The server and client choose a property *p* and a property *g*; these properties are shared by both the server and the client. Each end then computes a random private key integer *priv_key*. The length of *priv_key* is at most (number of bits in *p*) - 1. (Parameter *p* is a prime number and parameter *g*, usually called a generator, is an integer less than *p*).

A public key is then generated for both ends based on *g*, *priv_key*, and *p*. The keys are then exchanged. The shared secret key is generated based on the exchanged public key, the private key, and p. The mathematical principles involved insure that both parties will generate the same shared secret key.

The key length are:

- Public Key (prime number) length: 768 bits; 1024 bits; 1536 bits; 2048 bits.
- Private Key length: from 160 to 240 bits.

Managing SSH

Normally the default SSH configuration would support most secure connection scenarios, but SSH provides a variety of configurable parameters for specific requirements. These parameters are described that follow. To view the current SSH settings, use the following command.

```
-> ssh list
```

SSH Sessions

For SSH to be operational, the following must be performed:

- Add the enabling feature key
- Generate or install a public/private key pair

Assuming these steps have been performed, secure connections to the system are available. When SSH is enabled (default mode), it listens on port 22 for a client to initiate a secure session. Secure sessions can be initiated regardless of the "trusted" or "untrusted" condition placed on the interface via Secure Mode Access.

SSH can be enabled and disabled via the Web Interface Secure Shell Configuration page or by using the following command:

```
-> ssh set status <enable | disable>
```

SSH can also be configured to use a different port using the Web Interface SSH Configuration form or by entering the following command:

```
-> system sshport <port>
```

A connection timeout period can also be configured that will define the amount o time an SSH connection will be allowed to remain idle (in seconds) before the session is disconnected. The default value is 10 minutes and can be configured with a range of 30 seconds to 20 minutes. This setting is defined on the Web Interface SSH Configuration form or by entering the following command:

```
-> ssh set idletimeout <seconds>
```

Keys

Key Generation

Since no public/private key pairs are automatically generated for the system, once SSH has been key-enabled, the first step in setting up SSH is to generate a key pair. There are two options for key generation:

- Keys can be generated from locally from the router using the Web Interface Key Generation form or by using the following command:

```
-> ssh keygen
```

☞ **NOTE:**

The Key Generation function may take in excess of 1 hour to complete. A reboot of the router will terminate the process and will result in no keys having been generated.

- Key pairs can also be generated with SSH corporations Key Generation software (only) offline and then installed onto the system. The keys can be installed via the Web Interface Load Keys form, or by using the following commands:

```
-> ssh load privatekey tftp@<server-addr>:<priv-key-file>
-> ssh load publickey tftp@<server-addr>:<pub-key-file>
```

Re-Key Interval

If required, a Diffie-Hellman re-key interval can be specified. The interval can be set from every minute to 10 hours. Increments are whole minutes with 60 the default setting. Since some clients may not have the ability to re-exchange keys, a value of zero (*0*) can be set to disable re-key exchanges. This parameter is configured on the Configure SSH form or by entering the following command:

```
-> ssh set rekey <interval>
```

Encryption Options

The following encryption options are supported for SSH communication. The selected method is configured locally on the router (or server). When a client initiates a session, the encryption type is realized and the client adheres to the server encryption mode. If the encryption method is not supported on the client side, the connection will fail. All encryption is performed via software algorithm. The encryption options supported include:

DES

DES is a symmetric secret key algorithm. The key size is 64-bits. It is commonly known as a 56-bit key as the key has 56 significant bits; the least significant bit in every byte is the parity bit.

3DES

Triple DES or 3DES is a version of DES that consists of a DES encryption with one key, a decryption with a second key and then an encryption with a third key. The result is equivalent to DES with a 168 bit key. 3DES is the default encryption method.

Twofish

Twofish uses 40 32-bit subkeys. The first eight are used for whitening, four at the beginning and four at the end are XORed with the entire block. Each round uses two of the remaining 32 subkeys, and so Twofish has sixteen rounds.

The division of the 128-bit block into four 32-bit quarters is done using the "little-endian" convention, which presumably means the left-most quarter is the earliest one, but the least significant numerically.

Blowfish

Blowfish is a block cipher that encrypts data in 8-byte blocks. The algorithm consists of two parts: a key-expansion part and a data-encryption part. Key expansion converts a variable-length key of at most 56 bytes (448 bits) into several subkey arrays totaling 4168 bytes. The resulting key supported is 128-bits.

ACR4

ARCFOUR, a public domain algorithm, is a stream based cipher that can use a variable length key. The key size supported is 128-bits.

Procedure

To change the prescribed encryption method, access the SSH Configuration form in the Web Interface or use the following command:

```
-> ssh set encryption <type>
```

Authentication

Two methods of Message Authentication Code (MAC), MD-5 and SHA-1, are supported for data integrity. The MD-5 algorithm takes an message of arbitrary length and produces a 128-bit "fingerprint" or "message digest" of the input that is used as the authentication data. SHA-1 methodology is similar, but yields a 160-bit key.

Procedure

To change the prescribed encryption method, access the xxx form in the Web Management Interface or use the following command:

```
-> ssh set mac <md5 | sha1>
```

Bridge Filtering

You can control the flow of packets through the router using bridge filters. The filters can “deny” or “allow” packets to cross the network based on the content of the packets. This feature lets you restrict or forward messages with a specified address, protocol, or data content. Common uses are to prevent access to remote networks, control unauthorized access to the local network, and limit unnecessary traffic.

For example, to restrict remote access for specific users, you could define bridge filters using the local MAC address of each user to be restricted. Each bridge filter is specified as a “deny” filter based on the MAC address and position of the address within the packet. Deny filtering mode is then enabled to initiate bridge filtering. While in deny mode, all packets containing one of the filtered MAC addresses are denied bridging across the router.

Similarly, protocol filtering can be used to prevent a specific protocol from being bridged. In this case, the protocol ID field in a packet is used to deny or allow a packet. You can also restrict the bridging of specific broadcast packets.

Configure Bridge Filtering

Bridge filtering allows you to control the packets transferred across the router. This feature can be used to enhance security or improve performance. The filtering is based on matched patterns within the packet at a specified offset. Two filtering modes are available:

- "Deny" mode will discard any packet matched to the "deny" filters in the filter database and let all other packets pass.
- "Allow" mode will only pass the packets that match the "allow" filters in the filter database and discard all others.

Up to 40 "allow" filters or 40 "deny" filters can be activated from the filter database.

Enter the filters, including the pattern, offset, and filter mode, into a filter database. If you intend to restrict specific stations or subnetworks from bridging, then add the filters with a "*deny*" designation and then enable "*deny*" filtering. If you wish to allow only specific stations or subnetworks to bridge, then add the filters with an "*allow*" designation and enable "*allow*" filtering. Add each filter with the following command:

```
filter br add [pos] [data] [deny | allow]
```

where [*pos*] is the byte offset within a packet (number from 0-127) to a [*data*] (a hex number up to 6 bytes). This data and offset number can be used to identify an address, a protocol id, or data content. After entering your filters, verify your entries with the following command:

```
filter br list
```

If you have entered an incorrect filter, delete the filter using the filter br del command. When you are satisfied with the filter list, save the filtering database with the save filter command. You must reboot the router to load the filtering database. Then enable bridging filtering with the following command:

```
filter br use [none | deny | allow]
```

To test the filtering configuration, access the remote destination identified in the filter.

CHAPTER 6

CONNECTION MANAGEMENT

IP Subnets

You may configure the router to provide access to multiple IP subnets on the Ethernet network. (This feature does not apply to IPX or bridged traffic.)

Each IP subnet is referenced as a logical (or virtual) Ethernet interface. You may define multiple logical interfaces for each physical Ethernet interface (that is, port) in the router. Each logical interface is referenced by its port number and logical interface number (port #:logical#).

Logical Interface Commands

To define a logical interface, first use the eth add command; it specifies the port number and the new logical interface number. You then enter an eth ip addr command to define the IP address and subnet mask of the IP subnet.

The default logical interface for each port is interface 0; this logical interface 0 always exists and cannot be deleted. (Other logical interfaces may be deleted using the eth delete command.)

Stopping and Starting an Interface

You can stop and start a logical interface without rebooting the entire router. To do so, use these commands:

```
-> eth stop
```

Stops a logical Ethernet interface

```
-> eth start
```

Starts a logical Ethernet interface

```
-> eth restart
```

Stops and restarts a logical Ethernet interface

☞ **NOTE:**

When you stop or restart an interface, interface changes are discarded if they have not been saved.

Interface Routing and Filtering

After the eth add and eth ip addr commands define the Ethernet logical interface, other eth commands can reference it, including:

```
-> eth ip addroute
```

Adds an Ethernet IP route that uses the logical Ethernet interface. The route is added to the default routing table.

```
-> eth ip bindroute
```

Adds an Ethernet IP route that uses the logical Ethernet interface. The route is added to a virtual routing table

```
-> eth ip filter
```

Manages IP filters for the logical Ethernet interface. Lists of input, output, and forward filters may be defined for the interface

```
-> eth ip options
```

Sets RIP options for the logical interface; these options set IP routing information protocol controls

☞ **NOTE:**

In general, logical interface commands are not effective until you save the change and either restart the logical interface or reboot the router. However, the eth ip bindroute and eth ip filter commands are effective immediately if the logical Ethernet interface is already active.

Virtual Routing Tables

The virtual routing feature allows you to define multiple routing tables. This is also known as IP virtual router support.

To define a new routing table, you must specify a name for the routing table and a range of IP source addresses that use that table. The router determines which routing table to use based on the source address in the packet. For example, if the router receives a packet whose source address is 192.168.254.10, it checks if that address is within the address range defined for a virtual routing table. If it is, the virtual routing table is used to route the packet. If it is not, the default routing table is used instead.

The address ranges assigned to the virtual routing tables may not overlap. All source IP addresses not assigned to a virtual routing table are routed using the default routing table. You can add routes to the default routing table using the eth ip addroute and remote addiproute commands.

Procedures

Unlike changes to the default routing table, changes to IP virtual routing tables take effect immediately. However, the changes are lost if they are not saved before the next reboot.

Managing Routing Tables

The following command adds a range of IP addresses to a virtual routing table. The virtual routing table is defined if it does not already exist.

```
-> system addiproutingtable
```

To delete a range of IP addresses from the range defined for a virtual routing table or delete the entire table, enter the following command.

```
-> system deliproutingtable
```

The following command will move a range of IP addresses from their current assignment to the specified virtual routing table. The virtual routing table is defined if it does not already exist.

```
-> system moveiproutingtable
```

Managing Routes

To add an Ethernet route to a virtual routing table, use the following command:

```
-> eth ip bindroute
```

To remove an Ethernet route from a virtual routing table, use the following command:

```
-> eth ip unbindroute
```

To add a remote route to a virtual routing table, use the following command:

```
-> remote bindipvirtualroute
```

To remove a remote route from a virtual routing table, use the following command:

```
-> remote unbindipvirtualroute
```

RIP Controls

The Routing Information Protocol (RIP) control options allows you to decide what routing information you want to receive and what routing information you choose to share on the network.

For a remote interface, the default is to *not* send or receive IP RIP packets. If you choose to use this default, you *must* use the remote addiproute command to configure static routes for this WAN link.

The router can be configured to send and receive RIP packet information, respectively, to and from the remote router. This means that the local site will “learn” all about the routes beyond the remote router and the remote router will “learn” all about the local site’s routes. You may not want this to occur in some cases. For example, if you are connecting to a site outside your company, such as the Internet, you may want to keep knowledge about your local site’s routes private.

To see the current settings for a remote interface, use the remote list command and check the output lines:

```
Send IP RIP to this dest.............. no
    Send IP default route if known..... no
Receive IP RIP from this dest........ no
    Receive IP default route by RIP.... no
```

For an Ethernet interface, the default is to:

- receive and process IP RIP-1 compatible and RIP-2 broadcast packets from the Ethernet LAN.
- receive and process RIP-2 packets that are multicast as defined by the eth ip ripmulticast command.
- transmit RIP-1 compatible broadcast packets and RIP-2 multicast packets over the Ethernet LAN.

To see the current settings for an Ethernet interface, use the eth list command and check the output lines:

```
-> eth list
Send IP RIP to the LAN................ rip-1 compatible
     Advertise me as default router..... yes
Process IP RIP packets received...... rip-1 compatible
     Receive default route by RIP....... yes
```

To set or clear RIP options for a remote interface or an Ethernet interface, use these commands:

```
-> remote setipoptions <option>  on | off  <remotename>
```

The available RIP options on these commands are:

rxrip - Receive IP RIP packets

txrip - Send IP RIP packets

rxrip1 - Receive and process RIP-1 packets only

txrip1 - Send RIP-1 packets only

rxrip2 - Receive and process RIP-2 packets only

txrip2 - Send RIP-2 packets only

rxdef - Receive the default route

txdef - Advertise this router as the default router

avdfr

Advertising the Local Site

The default is to keep the local site's existence private. Unless specified otherwise, the remote does not advertise its route to other sites. This security mechanism is useful when the remote connects to a site outside your company (an Internet Service Provider, for example), or whenever you want to keep the identity of the site private.

To see the current setting, enter the remote list command and check the output line:

```
-> remote list

Keep this IP destination private..... yes
```

To turn off this security mechanism, use this command:

```
-> remote setipoptions private off <remotename>
```

Changing the Multicast Address for RIP-2 Packets

The default multicast address for RIP-2 packets sent and/or received is 224.0.0.9. If necessary, you can change this address with the eth ip ripmulticast command.

To see the current setting, enter the eth list command and check the output line:

```
-> eth list

RIP Multicast address.............. default
```

ARP

ARP is a low-level protocol within TCP/IP that "maps" IP addresses to hardware MAC addresses. ARP works by broadcasting an ARP request with the IP address out onto the network. The node with that IP address responds to the request with the MAC address of its Ethernet adapter. (The MAC address is hard-coded on the Ethernet adapter). The node that sent the request updates its ARP table with a new mapping of the IP-to-MAC address.

Multicast Forwarding Controls

The forwarding of multicast packets by an interface depends on the setting of the multicast IP option for that interface. To turn on multicast forwarding for a remote interface, use the command:

```
-> remote setipoptions  multicast  on  <remotename>
```

If any remote interface has multicast forwarding enabled, then multicast forwarding is automatically enabled on all Ethernet interfaces. However, multicast forwarding can be turned off or turned on for an Ethernet interface using the command:

```
-> eth ip options  multicast  on | off  <interface>
```

To see the current setting, use the eth list command and check the output line:

```
-> eth list

Multicast forwarding enabled....... no
```

Dial Backup

The Dial Backup capability provides a backup asynchronous modem connection to the Internet when the default DSL link goes down. If your router model is equipped with an internal modem and the feature key is present, the backup connection uses the internal modem; otherwise the backup connection uses an external modem. The modem connection is provided through the MGMT (console) port. In this case, the console port is used as a serial port and must be connected to an external modem.

☞ **NOTE:**

The Dial Backup feature is effective using either V.90 or ISDN modems.

Dial Backup is intended for customers with critical applications for which continuous Internet access is vital. If the DSL link for those applications goes down, the router can automatically switch their traffic to the asynchronous modem. Later, after determining that the DSL link is, once again, up and stable, the router automatically switches the modem traffic back to the DSL link.

This feature may also be useful for a customer whose DSL line is not yet installed. The router can begin providing service through an asynchronous modem and later automatically switch to the DSL link when it becomes available.

Dial Backup can be used with a VoDSL (voice over DSL) router. However, when data traffic is switched to the backup modem or restored to the DSL connection, all voice calls are terminated.

Dial Backup with a Tunnel

Dial Backup works with L2TP and IPSec tunneled connections. However, an IPSec tunnel from the backup interface must use IKE aggressive mode, not IKE main mode, because, it is assumed that the ISP assigns an IP address to the backup interface dynamically (see “Main Mode and Aggressive Mode” on page 5-54.)

You may wish to restrict an L2TP tunnel or IPSec tunnel to only the primary interface or only the backup interface:

If you do not want tunnel traffic to go through the backup asynchronous modem, you should restrict the tunnel to use only the primary interface. With this restriction in place, if the primary interface fails, the tunnel is terminated, and it is not re-established with the backup interface.

Or, you might want a tunnel to be established only when the asynchronous modem is being used. In this case, you would restrict the tunnel to the backup interface only.

To set either restriction for an L2TP tunnel, use the l2tp set wanif command. On the command, you specify the remote name that the tunnel is restricted to and the tunnel name. To restrict the tunnel to the backup interface, specify the remote name that you created for the dialup parameters as described in “Specifying Modem Parameters” on page 6-14.

To set a restriction for an IPSec tunnel, use the ike ipsec policies set interface command. The interface that you specify on the command is the remote interface that the tunnel is to be restricted to. To restrict the tunnel to the backup interface, specify the remote name that you created for the dialup parameters as described in "Specifying the Dialup Parameters" on page 6-9.

Configuring Dial Backup

To set up the router to use the Dial Backup feature, you must:

- If your router has an internal modem and you choose to use it, a feature key must be installed (see "Key Enabled Features" on page 4-29); if not, an external modem must be used.
- Connect an asynchronous modem to the console port of the router if required.
- Special DB9 or DB25 connectors may be required. Special modem kit and/or connector packages are available from Efficient Networks.
- Configure the router software to use the Dial Backup feature.

To begin Dial Backup configuration, you can select options using the Web Management Interface ("Dial Backup" on page 8-68) or review the sample configuration discussed in this chapter. Further configuration may require the CLI commands described in this section.

☞ **NOTE:**

Because Dial Backup uses the console port, you cannot enter CLI commands using the console port while Dial Backup is enabled. While Dial Backup is enabled, you must access the command line via Telnet.

The following is a general outline of the steps required to configure Dial Backup. These steps are detailed in the sections that follow. To configure Dial-Backup:

Step 1 Check that the Internal Modem feature is installed in the router. To do so, enter the key list command and look for the presence of a *Intmodem* key in the list. For more information, see "Listing the Installed Feature Keys" on page 4-32. If no key is present, an external modem must be connected.

Step 2 Define a remote profile for Dial Backup that specifies the ISP phone number and other dialup parameters.

Step 3 Specify the conditions that determine the status of the DSL link. Default values are provided for:

- Minimum stability period for the DSL link status signal
- Minimum retry period before DSL link restoration is attempted

Optionally, Dial Backup can actively test the status of the DSL link by pinging IP addresses. For this option, you must specify at least one IP address; default values are provided for:

- Ping interval, number of samples, and minimum success rate

Step 4 Specify the modem parameters (if the default values are not appropriate).

Step 5 Enable Dial Backup by doing all of the following:

- Check that the remote profile created in step 2 is enabled (use the command: remote list).
- Enter the command: system backup enable
- Enter the commands: save and reboot.

☞ **NOTE:**

The router determines only at reboot whether its serial port is to be used for console output or for Dial Backup. If Dial Backup is enabled at reboot, then the serial port is assigned to Dial Backup and console output is not sent to the serial port; this cannot change until the next reboot.

Task Complete

Specifying the Dialup Parameters

To use the asynchronous modem to connect to the ISP, the router requires a remote entry defining the connection parameters for the serial port.

Dial Backup can be enabled only when a remote entry exists that:

- defines an asynchronous interface using the PPP protocol,
- specifies at least one phone number,
- specifies a user name, and
- is enabled.

The remote entry should also turn off authentication and specify a remote route.

The following is an example of commands that define a Dial Backup remote profile named backup.

```
remote add backup

# Define the interface as asynchronous and using the PPP protocol.

remote setprefer async backup
remote setprotocol ppp backup
```

```
# Specify the primary phone number to be used when dialing out. This

# phone number begins with 9 (to get an outside line), a comma (for

# a 2-second pause), and finally the seven-digit local number.

remote setphone async 1 9,5554218 backup

# Specify the bit rate for the preceding phone number.

# The bit rate can be 38400, 57600, 115200, or 230400.

remote setspeed 115200 async 1 backup

# Specify the alternative phone number to be used and its bit rate.

remote setphone async 2 9,5554219 backup
remote setspeed 115200 async 2 backup

# Specify the name and password provided by the ISP.

remote setoursysname GWBush backup
remote setourpasswd Dubya backup

# Turn off authentication.

remote disauthen backup

# Turn on Network Address Translation.

remote setiptranslate on backup

# Add a default route for the backup entry

remote addiproute  0.0.0.0  0.0.0.0  1  backup

save
```

ISDN Phone Numbers

If you use an ISDN Terminal Adapter (TA) instead of a V.90 modem, the remote profile for the Dial Backup should:

- specify an asynchronous interface (remote setprefer async) and,
- if the two B channels require different phone numbers, specify both phone numbers on one remote setphone command. The two phone numbers are separated by an & character. For example, the following command specifies the two phone numbers 555-2000 and 555-4000:

```
-> remote setphone async 1 5552000&5554000 backup
```

Setting DSL Link Conditions

After you define the backup connection parameters in a remote profile, the following information is included when you enter the command system list:

```
-> system list

Backup.............................. yes
Retry Interval In Minutes.......... 30
Stability Interval In Minutes...... 3
```

By default, Dial Backup determines that the DSL link has failed if it detects No DSL link status signal. If the signal remains down for a minimum time (the stability period), the DSL link is assumed to be physically disconnected and down.

Optionally, you may also specify one or more IP addresses to ping to determine that the link is down. This is discussed later under “Addresses to Ping” on page 6-12.

Stability Period

DSL link failure is indicated if the DSL link status signal remains down for a minimum time. This minimum time is the stability period that guards against frequent switching back and forth between the DSL link and the backup port.

The default stability period is three minutes. To change the stability period, use this command:

```
-> system backup stability <minutes>
```

The minimum stability period is one minute.

DSL Restoration Retry Period

Once DSL link failure is determined, the router uses its console port as a serial port and data traffic is sent and received through the asynchronous modem connected to that port. This backup port continues to be used until it is time to check whether the DSL link has been restored. This time period between checks is called the retry period (default, 30 minutes).

When the retry period expires, the router determines if the DSL link has been restored. To do so, it first determines if the DSL link status signal has been up for the minimum stability period. If it has, then the router stops the data traffic going through the backup asynchronous modem, and checks whether the DSL link can be used instead.

If you have specified one or more ping addresses, the router pings those addresses via the DSL link. If the DSL link fails the ping test, the router once again switches data traffic to the backup port until the retry period expires again.

However, if the DSL link passes the ping test, the DSL link is assumed to be restored and it is used for data traffic until another failure is detected.

The default retry period is 30 minutes. To change the retry period, enter this command:

```
-> system backup retry <minutes>
```

Addresses to Ping

Dial Backup can also actively determine whether the DSL link is up by pinging IP addresses. It does so only if you provide it with one or more IP addresses.

You could choose to ping addresses that are vital to your application. The router pings these addresses at the interval you specify (default, every 5 seconds). It compares a specified number of samples (default, 6) against the specified minimum success rate (default, 50%). If the success rate is less than the minimum, the DSL link is assumed to be down.

If you specify one or more addresses, the router pings those addresses to determine if the DSL link is up. You may request that the router ping any or all of these:

- One or more specific IP addresses (four decimals separated by periods)
- Your gateway address (GW)
- Your domain name server address (DNS).

The router determines your gateway and/or DNS address implicitly via a means such as DHCP, static configuration, PPP negotiation, etc.

If you specify more than one address to ping, you may want to assign the addresses to groups. Each group can be assigned its own ping interval, number of samples, and success rate. For example, you might want the success rate for the DNS address to be at least 95%, while a success rate of 50% would be reasonable for a heavily used website. You can also disable and re-enable ping addresses by group. A group is identified by its number (0 through 65535).

To add an address to the ping list, use this command:

```
-> system backup add <ipaddr> | gw | dns | [<group>]
```

After you enter a ping address, you can see the ping list using the command system list. For example, the addresses in this ping list are the gateway (GW) address and the domain name server (DNS) address:

```
IP Address(es).........GW
                       DNS
```

To remove an address from the ping list, use this command:

```
-> system backup delete <ipaddr> | gw | dns | [<group>]
```

To remove a group of addresses, enter:

```
-> system backup delete all [<group>]
```

To clear the ping list of all addresses, enter:

```
-> system backup delete all all
```

☞ **NOTE:**

If you clear the ping list of all addresses, pinging is not used to determine if the DSL link is down. Instead, the state of the DSL physical layer is the only criterion used to determine failure and restoration.

Ping Interval, Number of Samples, and Success Rate

After you enter an address in the ping list, the system list command lists the following Dial Backup information:

```
Backup.............................. yes
   Retry Interval In Minutes.......... 30
   Stability Interval In Minutes...... 3
   Backup Group....................... 0
      Group Enabled.................... yes
      Ping Interval In Seconds......... 5
   Number Of Ping Samples............. 6
   Target Success Rate................ 50
   Current Success Rate............... 100
   IP Address(es)..................... GW
```

By default, the router pings the addresses every 5 seconds until it has pinged each address 6 times; it requires a minimum success rate of 50%. You may need to adjust these default values to fit your situation; for example, if pings are failing, you may want to lower the required success rate. To change these values, use these commands:

```
-> system backup pinginterval <seconds> [<group>]
-> system backup pingsamples <seconds> [<group>]
-> system backup successrate <percentage>[<group>]
```

☞ **NOTE:**

To disable a group of ping addresses, specify 0 for any of its three values - pinginterval, pingsamples, or success rate.

The same ping interval, number of samples, and success rate apply to all addresses assigned to a group. (Any address not assigned to a group is considered to belong to group 0.) All groups are tested in parallel. As soon as any group fails its success rate test, the DSL link is assumed to have failed and the switchover to the backup is performed.

During the ping test, every address in a group contributes to the current success rate of the group; as soon as the current success rate falls below the minimum success rate, the group has failed. For example, if the minimum success rate is 50% and the sample number is 6, the maximum sample size for a three-address group is 18 (6 times 3); thus, as soon as the group accumulates 10 failures (one more than 9 failures, which is 50% of 18), the group fails.

Specifying Modem Parameters

When using the internal modem (if available), the modem parameters are preconfigured. If you are suing an external modem, you need to provide the router with modem parameters so it can effectively use the asynchronous modem connected to the console port. A default modem setup is provided. To see the default settings, enter:

```
-> system default modem

-> system list

MODEM STRINGS:
   Reset:    ATZ
   Escape:   +++
   Init:     ATS0=0Q0V1&C1&D0X4S12=20
   Off-Hook: ATH1
   Dial:     ATDT
   Answer:   ATA
   Hangup:   ATH0
```

To change the modem settings from the defaults, specify which setting you want to change and the new string. To do so, use this command:

```
-> system modem reset | escape | init | offhook | dial | answer
| hangup <string>
```

For example, the following command changes the string for the init setting:

```
-> system modem init ATS0=0Q0V1&C2&D3&K1X4&H1&I0S12=20
```

Init Setting

The modem init string should set the following:

DTR	off	Supress results	on
Verbal	yes	detect	off
Echo	no	Carrier detect	off

Use HyperTerminal directly connected to the modem to determine the modem init string before connecting the modem to the router.

Dial Setting

The string for the dial setting can be either ATDT for tone dialing or ATDP for pulse dialing. The default is tone dialing. To select pulse dialing, use this command:

```
-> system modem dial atdp
```

Disabling and Re-Enabling Dial Backup

Note: Because Dial Backup uses the console port, you must use the Web GUI interface or a Telnet session to disable Dial Backup.

To temporarily disable Dial Backup, enter the following command:

```
-> system backup disable
```

This command stops Dial Backup. However, temporarily disabling Dial Backup does not change the use of the console port (no console output is sent to the console port).

To re-enable Dial Backup after it has been temporarily disabled, either reboot without a save or enter this command:

```
-> system backup enable
```

☞ **NOTE:**

You can change the setting of the Dial Backup enable switch at any time, but toggling the switch does not immediately change the use of the console port. The use of the console port is determined only at reboot.

To disable Dial Backup across reboots and change the use of the console port, enter the following commands:

```
-> system backup disable
-> save
-> reboot
```

Assuming that the Dial Backup remote profile is enabled, you can re-enable the Dial Backup feature using the following commands:

```
-> system backup enable
-> save
-> reboot
```

VRRP Backup

When a router is defined as a static default gateway and no other dynamic routing protocol or router discovery protocol is used (such as RIP), the gateway becomes a critical link in the network. If that router fails, that critical link would be broken. It, therefore, may be appropriate to set up other routers as backups that can serve as the static default gateway if necessary.

The Virtual Router Redundancy Protocol (VRRP), as defined in RFC 2338, allows other IP routers in a LAN to provide immediate and automatic backup to a failed IP router. VRRP is a protocol that defines how backup routers monitor the status of a master router and take over its function if it fails. The new master router adopts the IP and MAC address of the original master, so that the hosts configured with the single default gateway maintain their network connection.

The following illustration shows two routers connecting a LAN to the Internet. By using VRRP, the backup router can take over as the gateway if the master router fails.

Routers using VRRP send out advertisement packets at intervals to let the other VRRP routers on the LAN know that they are still up. The other VRRP routers realize that a router is down when no advertisement packets have been received for the minimum down interval. The VRRP router assigned the highest priority takes over for the failed router. When the failed router is restored, it can automatically preempt the backup router and resume its function in the network.

VRRP Configuration

To configure a LAN to use VRRP, you must enter configuration commands into every router that is to be provided with backup or that is to serve as backup to another router. Certain values must be the same between the master router and its backups; other values must differ (as discussed in the following sections).

VRRP configuration requires these basic steps:

1. Define logical interfaces.
2. Define the ID of the Virtual Router (VRID).
3. Define the VRRP attributes of the Virtual Router.
4. Save the changes and either restart the VRRP interface or reboot the router.

Defining the VRRP Interface

Each router that is to use VRRP must have at least two logical Ethernet interfaces defined, one to be used as the VRRP interface and the other as the management interface. (Logical interfaces are discussed under “IP Subnets” on page 6-1.)

The VRRP interface is for VRRP use only; it cannot be used for any other purpose. Unlike other logical interfaces, the VRRP interface does not use the usual Ethernet MAC address associated with the router. Instead, it uses the VRRP MAC address as defined in RFC 2338, that is, 00005e0001xx where xx is the VRID.

IP Address

Every logical interface is assigned its own IP address, or range of addresses, that is unique on the LAN. The VRRP interface must be assigned the IP address that serves as the default static gateway for other devices on the LAN.

For example, assume that the gateway IP address is 192.168.100.254. If the default logical interface (0:0) is to be the VRRP interface, it is assigned the gateway address. Another logical interface (0:1) is defined to be the management interface and is assigned another IP address.

```
-> eth ip addr 192.168.100.254 255.255.255.0
-> eth add 0:1
-> eth ip addr 192.168.254.253 255.255.255.0 0:1
```

☞ **NOTE:**

You must assign the same IP address to the VRRP interface in the master router and in every router that is to serve as its backup. For example, if the VRRP interface is assigned IP address 192.168.100.254 in router A, the VRRP interface in every backup router for router A must be assigned IP address 192.168.100.254.

RIP Processing

Routers using VRRP do not need RIP protocol processing to discover routes. (See “RIP Controls” on page 6-4.) You may, therefore, turn off RIP processing using these commands:

```
-> eth ip options txrip off
-> eth ip options rxrip off
```

Defining the VRID

The next step is to define a virtual router ID, or VRID, and associate it with the logical Ethernet interface that is to be the VRRP interface. (The management interface is not assigned a VRID).

For example, the following command assigns the VRID 7 to the logical interface 0:1 that is to serve as the VRRP interface.

```
-> eth ip vrid 7 0:1
```

A VRID has these characteristics:

- Integer from 1 through 255; thus, a LAN can have up to 255 VRIDs.
- Unique on the LAN, but can be reused on other LANs.
- The same VRID must be defined in all routers that make up the Virtual Router, that is, the original router and all routers that are to serve as its backups. For example, if VRID 7 is defined in router A, then VRID 7 must also be defined in all backup routers for router A.

To see the effect of these commands, specify the logical interface on an eth list command. For example, the defined VRID is listed in the following output:

```
-> eth list 0:1

ETHERNET INFORMATION FOR <ETHERNET/0:1>, DOWN
Send IP RIP to the LAN.............no
Advertise me as default router......yes
Process IP RIP packets received.....no
Receive default route by RIP........yes
IP address translation.............no
IP filters defined..................no
IP address/subnet mask.............192.168.254.253/255.255.255.0
Management IP address/subnet mask...0.0.0.0/0.0.0.0
Virtual Router ID (vrid)............7
Static Ethernet routes defined......none
Virtual Ethernet routes defined.....none
MTU................................default
```

☞ **NOTE:**

A logical interface does not become effective until you save your changes and either restart the logical interface or reboot the router. The VRRP interface also requires the definition of its VRRP record before it becomes effective. See “Starting VRRP” on page 6-21.

Defining VRRP Attributes

Each time you define a VRID in a router, you must define an attribute record for it in that router. The following sections describe how to define the record and set the attributes.

☞ **NOTE:**

The VRRP attribute commands do not require a restart or reboot to take effect. However, you do need to save your changes if they are to persist after a restart or reboot.

Adding a VRID Attribute Record

To define a record to contain the attributes for a VRID in a router, use this command:

```
-> eth vrrp add <vrid> [<port#>]
```

The port number is needed only if the router is an Ethernet hub router with two ports (port 0 and port 1).

To see the VRID attribute records currently defined, use the eth vrrp list command, as follows:

```
-> eth vrrp list

VRRP Records for Ethernet Port ... 0
VRRP Record..................... VRID 7, Priority 100, Interval 1
                                 Flags:preempt, No Authenticaion
                                 No VRRP interfaces defined
```

Priority Attribute (0-255, default, 100)

The priority value determines which backup router takes over when a router fails. The master router must be assigned the highest priority (255). Lower priorities are assigned to its backup routers, that is, the other routers in which the same VRID is defined.

For example, suppose routers A, B, and C all have VRID 7 defined. If router B should take over if router A fails and if router C should take over if both A and B fail, you would assign priority 255 to A and lower priorities to B and C, such as, priority 100 to B and priority 50 to C.

The priority command is:

```
-> eth vrrp set priority <priority> <vrid> [<port#>]
```

Time Interval Attribute (default, 1 second)

The time interval value specifies how often VRRP advertisement packets are sent. It also determines how quickly a backup router can recognize that another VRRP router is down.

If the backup does not receive a VRRP packet from another VRRP router during the master down interval, the backup assumes the other router is down. The master down interval is:

Master _Down_Interval = (3 * Time_Interval) + Skew_Time

Skew_Time = (256 - Priority) / 256

Thus, the default skew time is (256 - 100) / 256, or .609375. The default master down interval is (3 * 1) + .609375, or 3.609375 seconds.

☞ **NOTE:**

The time interval must be the same for every router in the Virtual Router, that is, for every router in the LAN with the same VRID. For example, if a VRRP interface in routers A, B, and C has the VRID 7, routers A, B, and C must all specify the same time interval for VRID 7.

The time interval command is:

```
-> eth vrrp set timeinterval <priority> <vrid> [<port#>]
```

Password Attribute (no default)

You may specify an optional password of 1 to 8 characters. The password is only used to authenticate VRRP advertisement packets. It is sent as clear text on the LAN. If you do not specify a password, no password authentication is done.

☞ **NOTE:**

The password must be the same for every router in the Virtual Router, that is, for every router in the LAN with the same VRID. For example, if a VRRP interface in routers A, B, and C has the VRID 7, routers A, B, and C must all specify the same password for VRID 7.

The password command is:

```
-> eth vrrp set password <string> <vrid> [<port#>]
```

The command to clear the password is:

```
-> eth vrrp clear password <vrid> [<port#>]
```

☞ **NOTE:**

Our implementation does not validate the IP addresses in the advertisement packet or authenticate using an authentication header.

Preemption Option (default, preempt)

The preemption option determines what the router does when it recovers from a failure, as follows:

If the router is the master router for the IP address (it has priority 255), it always immediately preempts the backup router and resumes its function in the network. The preemption option cannot change this.

However, if the router is a backup router for the IP address and it determines that a router with a lower priority is currently functioning as backup, the preemption option determines whether this router immediately preempts the router with lower priority or waits for the lower priority router to go away before becoming the active VRRP router.

The preemption setting may differ among the backup routers for a VRID.

The preemption command is:

```
-> eth vrrp set option <preempt | nopreempt> <vrid> [<port#>]
```

Starting VRRP

After you have defined the VRRP logical interface, defined a VRID, and defined an attribute record for the VRID, you are ready to start VRRP. To do so, you must both save your changes and either restart the VRRP interface or reboot the router.

For example, these commands save all changes, restart the VRRP interface 0:1, and list the VRRP records:

```
-> save
-> eth restart 0:1
04/16/2001-07:49:04:VRRP: VRRP 7 on Interface ETHERNET/0 now active
-> eth vrrp list
VRRP Records for Ethernet Port ...  0
VRRP Record.....................  VRID 7, Priority 100, Interval 1
                                  Flags:preempt, No Authenticaion
                                  No VRRP interfaces defined

                                  Interface: ETHERNET/0:1
                                  VRRP Router active
```

After you start VRRP, you can use the eth vrrp list or eth list commands to monitor the status of the VRRP router.

Disabling or Deleting VRRP

To disable a Virtual Router in a router, you delete its VRID in that router. To do so, use the command:

```
-> eth vrrp delete  <vrid> [<port#>]
```

This command deletes the VRRP attribute record defined for that VRID. It also disassociates the VRRP IP and MAC addresses from the logical interface.

☞ **NOTE:**

To re-instate a deleted VRID, you need to redefine both the VRID and the VRRP attribute record. For example, the following commands disable VRID 7 and then re-enable it for the logical interface 0:0:

```
-> eth vrrp delete 7

-> eth ip vrid 7

-> eth vrrp add 7

04/16/2001-08:36:06:VRRP: VRRP 7 on Interface ETHERNET/0 now
active
```

To change the VRRP interface for a VRID, you clear the VRRP interface designation and then re-assign it. For example, to change the VRRP interface designation from 0:1 to 0:3 for VRID 7, use these commands:

```
-> eth ip vrid 0 0:1

-> eth ip vrid 7 0:3
```

If you wanted to remove VRRP entirely from the router, you would delete the VRID and also delete the extra logical interface you created for its use, with the command:

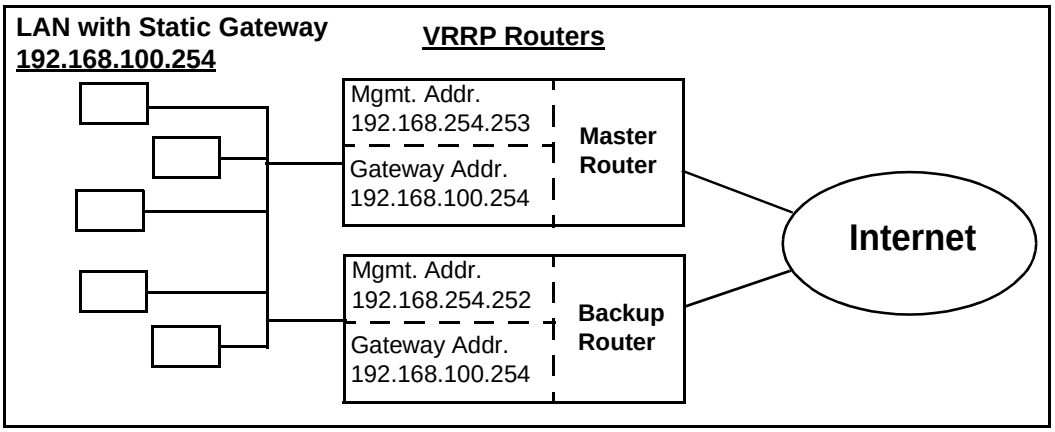
```
-> eth delete <port#>:<logical#>
```

☞ **NOTE:**

Remember, to make these changes permanent, you must save the changes before you must enter a save followed by an eth restart or reboot command.

Sample VRRP Configuration

The sample configuration shown here is for two routers, one master and one backup. It is assumed that either router can route Internet traffic for the Ethernet LAN containing devices that use a static default gateway address 192.168.100.254.



Master Router Configuration File

These are the VRRP configuration commands for the master router.

```
# A new logical interface 0:1 will serve as the management interface.
# It is assigned the IP address 192.168.254.253
eth add 0:1
eth ip addr 192.168.254.253 255.255.255.0  0:1
#
# RIP is not needed for either interface so it is turned off.
eth ip options txrip off
eth ip options rxrip off
eth ip options txrip off 0:1
eth ip options rxrip off 0:1
#
# The default logical interface 0:0 will serve as the VRRP interface.
# It is assigned the default gateway/LAN address is 192.168.100.254.
#
eth ip addr 192.168.100.254 255.255.255.0
#
# The VRRP interface 0:0 is assigned VRID 7.
```

```
eth ip vrid 7
#
# A VRRP attribute record is defined for VRID 7.
eth vrrp add 7
#
# This router is the master router so it is given priority 255.
eth vrrp set priority 255 7
#
# This is a simple password to authenticate VRRP packets.
eth vrrp set password abcdefgh 7
#
# Use the default time interval (1 second) and preemption option
(preempt).
#
# Save the changes and then reboot.
save
reboot
```

Backup Router Configuration File

These are the VRRP configuration commands for the backup router.

```
# These commands define a logical interface 0:1 to serve as the
management interface.
# It is assigned an IP address unique on the LAN, 192.168.254.252.
eth add 0:1
eth ip addr 192.168.254.252 255.255.255.0  0:1
#
# RIP is not needed for either interface so it is turned off.
eth ip options txrip off
eth ip options rxrip off
eth ip options txrip off 0:1
eth ip options rxrip off 0:1
#
```

```
# In this example, the VRRP interface is the default logical interface
0:0,

# (The VRRP interfaces for the master and backup routers may have
different numbers.)

#

# The VRRP IP address must be the same as that of the master router.

eth ip addr 192.168.100.254 255.255.255.0

#

# The VRRP interface must be assigned the same VRID as in the master
router.

eth ip vrid 7

#

# A VRRP attribute record is defined for VRID 7.

eth vrrp add 7

#

# The backup router must have a priority less than 255. Here, the
default, 100,

# is used.

eth vrrp set priority 100 7

#

# The backup router must have the same password as the master router.

eth vrrp set password abcdefgh 7

#

# The backup router must have the same time interval as the master
router. In this

# example, the default, 1 second, is used.

# The default preempt option is used; it is not required to be the
same as the

# master router.

#

# Save the changes and then reboot.

save

reboot
```

L2TP Tunneling - Virtual Dial-Up

This section has four parts:

- The Introduction provides a general overview of L2TP tunneling.
- The L2TP Concepts section explains LNS, L2TP client, LAC, dial user, tunnels, and sessions.
- Configuration describes preliminary configuration steps and verification steps and lists commands associated with the configuration of L2TP and PPP sessions.
- The Sample Configurations section provides two examples with step-by-step instructions: a simple L2TP client configuration example and a complete LNS and L2TP client configuration example.

Advantages of Tunneling

L2TP (Layer 2 Tunneling Protocol) is used to forward a PPP link from a remote site to a corporate site across the Internet, thus creating virtual paths called tunnels. Because tunneling involves encapsulating data, packets can be transported across networks using different protocols. The advantages for tunneling the PPP protocol are listed below:

- Different network protocols such as NetBEUI, IPX, and Appletalk can be transported through the Internet using a tunnel. The protocol packets are encapsulated and routed across the network through the Internet.
- Tunnels provide a way to reduce costs and complexity associated with remote dial-up networking by using a local ISP: users connect to the remote site by dialing into their local ISP and letting the Internet handle the long-distance connections, thus avoiding long-distance phone charges.
- Tunneling PPP allows compression of data through the entire tunnel, which translates into greater throughput.
- By allowing encryption over the PPP link, L2TP contributes to more secure networks over the Internet.
- Remote users can access the company network, even if there is a company firewall (provided, of course, that tunnels can come through the firewall).

☞ **NOTE:**

This feature can interoperate with any vendor that supports L2TP - Draft II.

L2TP Concepts

This section defines the major L2TP concepts and illustrates them with L2TP client examples. It also describes the creation and destruction of tunnels and sessions.

Definitions

An L2TP tunnel is created between an L2TP client and an L2TP network server (LNS). The client and server control the tunnel using the L2TP protocol.

L2TP Network Server (LNS)

Point where the call is actually managed and terminated (e.g., within a corporate network).

L2TP Access Concentrator (LAC)

Physical hardware (such as a router) used for placing and receiving phone calls.

Dial User

The remote system or router that is either placing the call to the LAC or receiving the call from the LAC. The dial user does not actually dial in to the LNS or receive a call from the LNS, since this is a virtual connection. The dial user is one end of a PPP session. The LNS is the other end of the PPP session.

L2TP Client

The dial user and LAC combined in the same hardware device. In this case, the PPP session is between the LAC and the LNS.

As shown in the Figure 6-1, an L2TP client is used to tunnel a PPP session between a small office (our router) and a corporate office through the Internet.

L2TP Client Illustration

The tunnel uses UDP/IP traffic as the transport medium over IP. This implementation of L2TP as illustrated below shows a tunnel from a remote user's perspective.

☞ **NOTE:**

There is one PPP session over ISDN and another PPP session over the tunnel.

LNS and L2TP Client Relationship

The LNS acts as the supervising system. The L2TP client acts both as the dial user and the LAC.

One end of the tunnel terminates at the L2TP client. The other end of the tunnel terminates at the LNS.

One end of the PPP session going through the tunnel terminates at the L2TP client acting as the dial user; the other end terminates at the LNS.

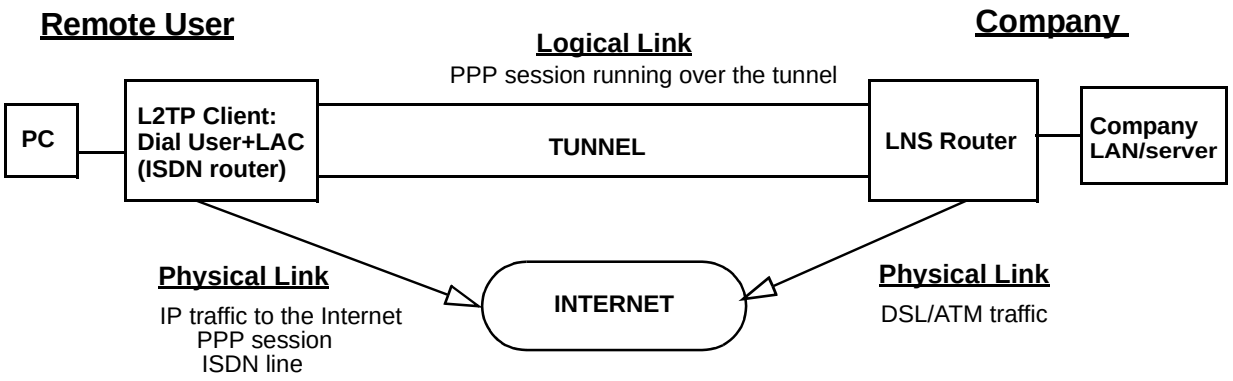


Figure 6-1: L2TP Example

Tunnels

- Tunnels are virtual paths that exist between an L2TP client and an L2TP server.
- An L2TP server can communicate simultaneously with more than one L2TP client.
- An L2TP client can communicate simultaneously with more than one L2TP server.
- Some L2TP implementations including the one discussed in this section allow the same router to act as both an L2TP client and an L2TP server simultaneously, if so configured.

CAUTION:

Verify that the IP address of the other end of the tunnel is correctly routed through the right, local interface/remote and will not appear to be routed through the tunnel. An attempt to route the tunnel endpoint within itself will fail.

Sessions

Sessions can be thought of as switched virtual circuit “calls” carried within a tunnel and can only exist within tunnels. One session carries one “call”. This “call” is one PPP session. Multiple sessions can exist within a tunnel. The following briefly discusses how sessions are created and destroyed.

- Session creation

Traffic destined to a remote entry (located at the end of the tunnel) initiates a tunnel session. When the L2TP client wishes to establish a session to an LNS, the L2TP client assumes the role of a LAC and sends control packets containing incoming call information to the LNS over the tunnel.

- Session destruction

A tunnel session automatically times out after the data session stops. When instructed to destroy a session, the L2TP client closes any PPP session associated with that session. The L2TP client may also send control messages to the LNS indicating that the L2TP client wishes to end the PPP session.

When the LNS wants to hang up the call, it sends control messages destroying the session.

Configuration

Preliminary Steps to Configure a Tunnel

The following logical steps should be considered before configuring a tunnel:

Step 1 Decide if the router should act as an L2TP Client or LNS.

Step 2 Decide if one side or both sides of the connection should be allowed to initiate a tunnel.

Step 3 Create the L2TP Tunnel Entry with these characteristics:

- The host name of the L2TP client
- The host name of the L2TP network server
- A Tunnel CHAP secret (both sides of the connection must use the same secret)
- The IP address of the other party must be provided to the initiating side of the tunnel
- Type of flow control (pacing, sequence numbers, or none)
- Create a remote entry for the PPP session. Associate the remote entry with the Tunnel.

Task Complete

Verification Steps

Step 1 Verify that the IP address of the other end of the tunnel is correctly routed through the right, local interface/remote and will not appear to be routed through the tunnel. An attempt to route the tunnel endpoint within itself will fail.

Step 2 Try to establish IP connectivity (using the ping or tracert commands).

a. "Pinging" from the L2TP client or LNS to the opposite tunnel endpoint should succeed (this tests the tunnel path).

b. "Pinging" from a tunnel endpoint IP address to an IP address within the tunnel will probably fail due to the existence of the IP firewall.

Task Complete

Configuration Commands

L2TP configuration commands are used to configure:

- Tunnels
- The PPP session

Commands to configure tunnels

For additional information, see Chapter 9, L2TP Commands in the Command Line Interface Guide.

Add an L2TP tunnel entry by name:

```
-> l2tp add <tunnelname>
```

The remote tunnel host name:

```
-> l2tp set remotename <name> <tunnelname>
```

The local tunnel host name:

```
-> l2tp set ourtunnelname <name> <tunnelname>
```

CHAP secret:

```
-> l2tp set chapsecret <secret> <tunnelname>
```

Tunnel authentication:

```
-> l2tp set authen on | off <tunnelname>
```

Type of L2TP support for tunnel: Configure the entry to act as a L2TP client, an L2TP network server (LNS), or as both a LAC and an LNS, or the entry can be disabled.

```
-> l2tp set type all | lns | l2tpclient  | disabled <tunnelname>
```

Remote tunnel IP address:

```
-> l2tp set address <ipaddr> <tunnelname>
```

☞ **NOTE:**

Verify that the IP address of the other end of the tunnel is correctly routed. It should not be routed through the tunnel itself, but over a physical link.

You may also specify the source IP address for the tunnel as an address other than the WAN interface IP address, such as the Ethernet IP address.

```
-> l2tp set ouraddress <ipaddr> <tunnelname>
```

Our PPP system name and secret/password:

The following commands specify the router's name and password/secret for authentication purposes on a per-tunnel basis.

```
-> l2tp set oursysname <name> <tunnelname>
```

```
-> l2tp set ourpassword <password> <tunnelname>
```

Other commands:

Commands are also available to delete a tunnel, close a tunnel, or set up advanced L2TP configuration features such as traffic performance fine-tuning (see Chapter 9, L2TP Commands in the Command Line Interface Guide).

Commands for PPP Session Configuration

Two commands are used to extend a PPP link from a remote site to a corporate site across the Internet and establish a tunnel. For more information, see "L2TP Tunneling - Virtual Dial-Up" on page 6-26..

```
-> remote setlns <tunneltame> <remotename>
```

```
-> remote setl2tpclient <tunnelname> <remotename>
```

Sample Configurations

Two sample configurations are described in this section:

- A simple configuration. This example describes the information needed to configure one side of the tunnel (the client side).
- A complete configuration. This example describes the information needed to configure both sides of the tunnel (client and server sides).

Simple L2TP Client Configuration Example

This example shows how a telecommuter working at home (client side) can configure his/her router SOHO to tunnel to the company's LAN (server side).

The information given in the Configuration Process section below provides a framework reference for this type of L2TP Client configuration.

Assumptions

In this example, the following information is assumed:

- The server side (the company) has an LNS router connected to the Internet.
- The client side has an existing route to the Internet with the remote “Internet” (refer to the following Note, if you need sample configuration commands).
- IP routing is enabled (refer to the following Note, if you need sample configuration commands).

☞ **NOTE:**
Below is an example of configuration commands that can be used to enable IP routing and establish a route to the Internet.

```
remote add internet
remote disauthen internet
remote setoursysname name_isp_expects internet
remote setourpass secret_isp_expects internet
remote addiproute 0.0.0.0 0.0.0.0 1 internet
remote setphone isdn 1 5551000 internet
remote setphone isdn 2 5553000 internet
eth ip enable
eth ip address 192.168.254.254 255.255.255.0
```

Configuration Process

The following sets of questions, answers, and configuration commands specific to the L2TP tunnel and the PPP remote will assist you in configuring the client side router SOHO (also referred to as home router). Note that the server side is referred to as either company router or router at work.

L2TP tunnel configuration

L2TP tunnel-specific questions

1. What is the host name of the router at home that the user is configuring?
2. What is the host name of the company router at work to which the user will tunnel?
3. What is the shared CHAP secret used for tunneling between the home router (client) and the company router (server)?
4. What is the IP address of the company router to which the user will tunnel?

L2TP tunnel answers. For our example, let’s assume the answers to the above tunnel-specific questions are as follows:

1. Home_Router
2. Work_Router

3. Shared_Secret
4. 10.0.0.1

L2TP tunnel configuration commands. These commands would be used to set up the L2TP tunnel information for our example:

```
l2tp add Work_Router
l2tp set ourtunnel Home_Router Work_Router
l2tp set chapsecret Shared_Secret Work_Router
l2tp set address 10.0.0.1 Work_Router
```

PPP remote configuration

PPP remote-specific questions:

1. What is the home router's name for PPP authentication?
2. What is the home router's secret for PPP authentication?
3. Does the home router need PPP authentication for the remote router (company router)?
   - If yes:
     - What is the remote router's name for PPP authentication?
     - What is the remote router's secret for PPP authentication?
   - If no:
     - Use the command remote disauthen <*remoteName*> where <remoteName> is the name used to refer to the company's router.

4. Does the remote router dynamically assign an IP address for this PPP session?
   - If yes:
     - Use IP address translation (NAT)
   - If no and the home router is to behave as a LAN at home:
     - Which IP address and network mask does the home router use for its LAN at home? Use the eth ip addr command to set the LAN at home. Do not enable IP address translation (NAT) for the remote (company) router.
   - If no and the home router is to behave as a host at home:
     - Which IP address does it use at home? Assuming an IP address of www.xxx.yyy.zzz, use the command:

       -> remote setsrcipaddr www.xxx.yyy.zzz 255.255.255.255 <*remotename*>

       -> remote setiptranslate on <*remotename*>
5. Which IP and network addresses does the home router access at work through this PPP session?

PPP remote answers. For our example, let us assume the answers to the above PPP remote-specific questions are as follows:

1. ppp_soho
2. ppp_soho_secret
3. We assume that this router will authenticate the router at work with the following information:
   - the company router's name is: ppp_work
   - the company router's PPP secret is: ppp_work_secret
4. We assume that the company's router will dynamically assign an IP address to the home router.
5. 172.16.0.0/255.240.0.0

PPP remote configuration commands. For our example, these commands would be used to set up the PPP remote information for tunneling to work:

```
remote add ppp_work
remote setlns Work_Router ppp_work
remote setpasswd ppp_work_secret ppp_work
remote setiptranslate on ppp_work
remote addiproute 172.16.0.0 255.240.0.0 1 ppp_work

l2tp set oursysname ppp_soho Work_Router
l2tp set ourpassword ppp_soho_secret Work_Router
```

Complete LNS and L2TP Client Configuration Example

The following information and illustration (Figure 6-2) provide a configuration example of an LNS and L2TP Client.

Assumptions

IP Addresses

The LNS server's LAN IP address is 192.168.100.1 (LNSserver) with a mask of 255.255.255.0.

The LNS has a WAN IP address of 192.168.110.1, which is used as the tunnel endpoint.

The LNS connects to the remote internet.

The L2TP Client's LAN IP address is 192.168.101.1 (soho) with a mask of 255.255.255.0. Additionally, 192.168.101.1 is also the tunnel endpoint within the L2TP client. The router soho connects to the remote isp.

Secret/password

A shared tunnel secret of "tunnelsecret" will be used.

PPP Authentication

The LNS will authenticate the client using PPP. The client will not try to authenticate the LNS using PPP. For PPP authentication, the L2TP client will be known as "lacclient" with a password of "clientpassword".

Tunnel

Only the L2TP client (soho) will initiate the tunnel and make the connection. The tunnel is routed through the remote internet which is the default route. The LNS server never calls the L2TP client (soho).

Note: *The CHAP secret is "clientPassword".*

Note: *The CHAP secret is "tunnelSecret".*

Note: *No CHAP secret is needed; the client does not authenticate the LNS server.*

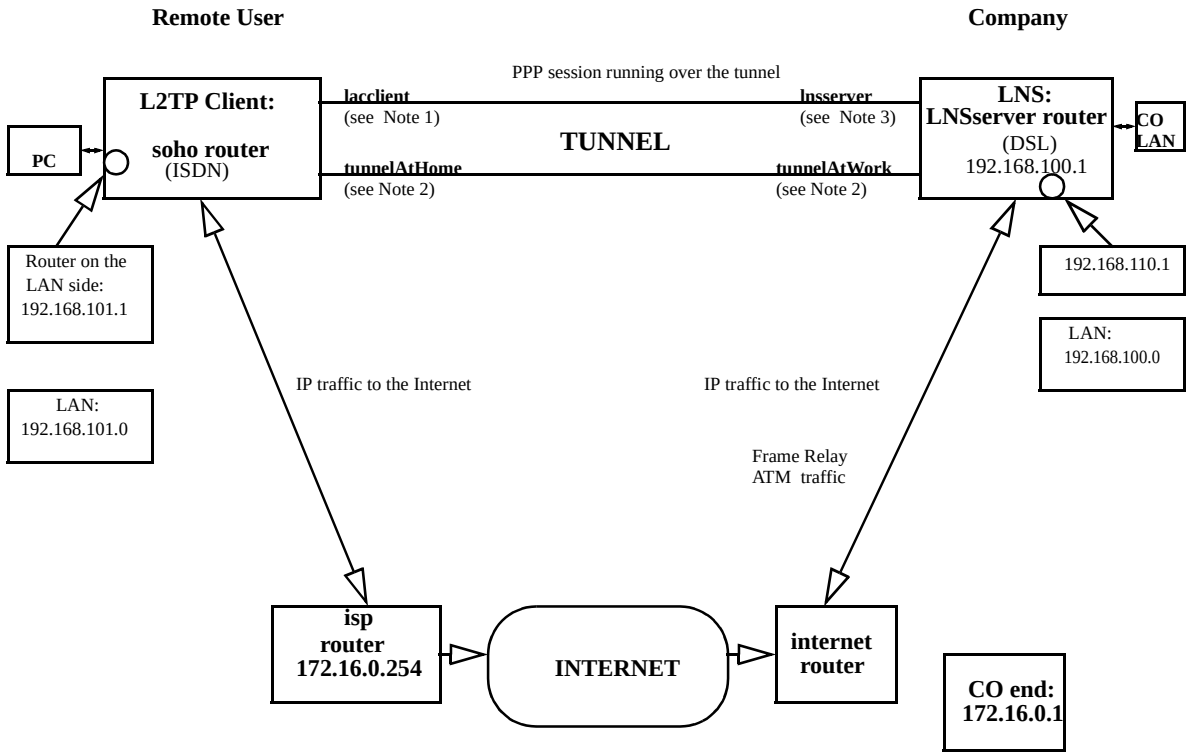


Figure 6-2: LNS and L2TP Client Configuration Example

Configuration Process

The following sample scripts list the commands used to configure the routers soho (L2TP client), LNSserver (LNS), internet, and isp.

Configuration commands for soho (L2TP client)

Note: *soho is an ISDN router.*

Define soho:

```
system name soho
system passwd sohopasswd
system msg configured_12/15/98
system securitytimer 60
```

Enable IP routing for soho:

```
eth ip enable
eth ip addr 192.168.101.1 255.255.255.0
```

Set up ISDN parameters:

```
isdn set switch ni1
isdn set dn 5551000 5553000
isdn set spids 0555100001 0555300001
```

Define DHCP settings for DNS servers, domain, wins server:

```
dhcp set value DOMAINNAMESERVER 192.168.100.68
dhcp set value DOMAINNAME efficient.com
dhcp set value WINSSERVER 192.168.100.73
```

Define a remote for the tunnel:

```
remote add lnsserver
remote disauthen lnsserver
remote setoursysname lacclient lnsserver
remote setourpasswd clientpassword lnsserver
remote setLNS tunnelAtWork lnsserver
remote addiproute 192.168.100.0 255.255.255.0 1 lnsserver
```

Define a remote isp:

```
remote add isp
remote setphone isdn 1 5552000 isp
remote setphone isdn 2 5554000 isp
remote disauthen internet remote addiproute 0.0.0.0 0.0.0.0 1
isp
```

Define the tunnel:

```
l2tp add tunnelAtWork
l2tp set chapsecret tunnelsecret tunnelAtWork
l2tp set ourtunnelname tunnelAtHome tunnelAtWork
l2tp set address 192.168.110.1 tunnelAtWork
save
reboot
```

Configuration commands for internet

Note: *internet is a DSL router. The router internet establishes a link to the LNS.*

Define internet:

```
system name internet
system passwd internet
system msg configured_10/15/01
system securitytimer 60
```

Enable IP routing and add routes:

```
eth ip enable
eth ip addr 172.16.0.1 255.255.255.0
eth ip opt rxdef off
eth ip addroute 192.168.101.1 255.255.255.0 172.16.0.254 1
```

Create a DHCP pool of addresses:

```
dhcp add 172.16.0.0 255.255.255.0
dhcp del 192.168.254.0
dhcp set addr 172.16.0.2 172.16.0.20
```

Set up DSL parameters:

```
sd term co sd speed 1152
```

Define a remote LNSserver

```
remote add lnsserver
remote setauthen chap lnsserver
remote setpasswd serverpassword lnsserver
remote addiproute  192.168.110.1 255.255.255.255 1 lnsserver
remote setprotocol ppp lnsserver
remote setpvc 0*38 lnsserver
save
reboot
```

Configuration commands for isp

Note: *isp is an ISDN router. The router soho calls the router isp.*

Define isp:

```
system name isp
system passwd isppasswd
system msg configured_12/15/98
system securitytimer 60
```

Enable IP routing:

```
eth ip enable
eth ip addr 172.16.0.254 255.255.255.0
```

Add a route to the other end of internet:

```
eth ip defgate 172.16.0.1
eth ip opt txdef off
```

Disable DHCP:

```
dhcp disable all
```

Set up ISDN parameters:

```
isdn set switch ni1
isdn set dn 5552000 5554000
isdn set spids 0555200001 0555400001
```

Define a remote (soho):

```
remote add soho
remote setauthen chap soho
remote setpassw sohopasswd soho
remote setphone isdn 1 5551000 soho
remote setphone isdn 2 5553000 soho
remote addiproute  192.168.101.0 255.255.255.0 1 soho
save
reboot
```

Configuration commands for LNSserver

Note: *LNSserver is a DSL router.*

Define LNSserver:

```
system name lnsserver
system passwd serverpassword
system msg Script_for_LNS_called_HQ
system securitytimer 60
```

Enable IP routing:

```
eth ip enable
eth ip addr 192.168.100.1 255.255.255.0
```

Define DHCP settings for DNS servers, domain:

```
dhcp set value domainname efficient.com
dhcp set value domainnameserver 192.168.100.68
```

Set up DSL parameters:

```
sd speed 1152
```

Define a remote for the Tunnel:

```
remote add lacclient
remote setpass clientpassword lacclient
remote setLAC tunnelAtHome lacclient
remote setauthen chap lacclient
remote addiproute 192.168.101.0 255.255.255.0 1 lacclient
```

Define a remote (internet):

```
remote add internet
remote setphone isdn 1 5552000 internet
remote setphone isdn 2 5554000 internet
remote setauthen chap internet
remote setpasswd internet internet
remote addiproute 0.0.0.0 0.0.0.0 1 internet
remote setsrcipaddr 192.168.110.1 255.255.255.255 internet
remote addiproute 192.168.101.1 255.255.255.255 1 internet
remote setprotocol ppp internet
remote setpvc 0*38 internet
```

Define the actual tunnel:

```
l2tp add tunnelAtHome
l2tp set chapsecret tunnelsecret tunnelAtHome
l2tp set ourtunnelname tunnelAtWork tunnelAtHome
save
reboot
```

PPPoE (PPP over Ethernet)

PPPoE is a method of delivering PPP sessions over an Ethernet LAN connected to a DSL line, as defined in the document RFC 2516. It was designed to maintain the established PPP interface for the end user and the service provider, while improving service through use of a DSL line.

- PPPoE allows the user to connect to a service provider using the same PPP interface as for a dialup connection, but the connection is through a DSL line, which provides greater speed and bandwidth.
- The service provider also perceives the connection as a standard PPP session, allowing for the same access control and billing per user as before.
- Multiple PPP users share the same DSL line to connect to an access concentrator.

Our router provides additional advantages to PPPoE users and service providers, as follows.

- Using our router, no software changes are required in the user PCs. Because the router acts as the PPPoE client, no PPPoE software is needed in the PC.
- Our router acts as both the PPPoE client and as the bridge connecting the Ethernet LAN to the DSL line. It does all IP address translation.
- The PPPoE client information (user name, password, and domain) are configured into the router. Once configured, the user does not need to enter them, ever.
- The following diagram illustrates how our router connects an Ethernet LAN to a service provider by serving as both the bridge and the PPPoE client.

Configuring for PPPoE

Configuring the router for PPPoE requires that at least two remote router entries be defined in the router. One remote router entry serves as a bridge for PPPoE traffic. The other remote router entry serves as the PPPoE client.

PPPoE Bridge

PPPoE requires a remote router entry defined for bridging. All PPPoE traffic must be bridged through the PVC or DLCI of a remote router entry. The entry can use any protocol that supports bridging including PPP, RFC 1483, or RFC 1490.

The remote entry must be enabled for bridging using the remote enabridge command.

The PPPoE bridge does not require the Spanning Tree Protocol. Turn off the protocol with this command:

```
-> remote setbroptions  stp  off  <remotename>
```

In addition, if the remote entry should be used only for PPPoE traffic, define it as "PPPoE only" using this command:

```
-> remote setbroptions  only  on  <remotename>
```

For a Dual-Ethernet router, an Ethernet interface can be designated as "PPPoE only" using this command:

```
-> remote setbroptions  pppoe only  on  <port#>
```

PPPoE Client

PPPoE configuration requires creation of a new remote router entry to serve as the PPPoE client. The PPPoE client provides the user name, password, and domain name required for each PPPoE session. In our router, we refer to the PPPoE domain name as a "service name" as described later.

The user name and password can be the router name and password provided by the system name and system passwd commands. Or a name and password can be specified for the remote router entry using the remote setoursysname and remote setourpasswd commands.

To create the entry, begin by entering these two commands:

```
-> remote add <remotename>

-> remote setpppoptions * <remotename>
```

The preceding two commands create a remote router entry that can be used to connect to all PPPoE services. To create an entry for a specific PPPoE service, use the following two commands:

```
-> remote add <remotename>

-> remote setpppoeservice <servicename> <remotename>
```

The service name is the domain name defined by your service provider.

After defining the remote entry with the remote add and remote setpppoeservice commands, enter commands to:

- Turn off authentication of the remote router by the target router (remote disauthen).
- •Specify the user name and password for the service (remote setoursysname and remote setourpasswd).
- Define the IP route for the remote (remote addiproute). (IP routing must be enabled for the Ethernet interface with eth ip enable.)
- Turn on Network Address Translation (NAT) if needed (remote setiptranslate).
- Permanently allocate a channel or allocate a channel only when needed (remote setminline).

If your service provider charges by the hour, you may want a PPPoE session to timeout after a period of no traffic. However, if you do use a timeout, bringing up a PPPoE session takes 2-3 seconds longer.

To permanently allocate a channel, use:

```
-> remote setminline 1 <remotename>
```

To set up a timeout, set the minline value to 0 and specify the timeout period in seconds, as follows:

```
-> remote setminline 0 <remotename>
```

```
-> remote settimer <seconds> <remotename>
```

Sample PPPoE Configuration Script

The following script is an example showing commands for a PPPoE configuration. The script assumes the following:

- The VPI/VCI for the connection is 0/35.
- The domain name for the service is DialUpPPP.net.
- The CHAP user name is JaneDoe and the CHAP password is Secret.
- Network Address Translation is desired for the PPPoE session.
- Only PPPoE traffic should pass through the bridge interface.
- Default IP route is used for the PPPoE session.

```
# Sample PPPoE Configuration Script
# --------------------------------
# Enable IP routing for the Ethernet interface.
eth ip enable
#
# Define a remote router entry (named PPPoEbridge) to serve as
# the bridge for PPPoE traffic only.
remote add  PPPoEbridge
#
# Set the link protocol (PPP, RFC 1483, RFC 1490).
remote setprotocol  rfc1483mer  PPPoEbridge
#
# Specify the VPI/VCI for ATM. (For Frame Relay, you would set the DLCI).
remote setpvc  0*35  PPPoEbridge
```

```
#
# Enable bridging through the remote.
remote enabridge  PPPoEbridge
#
# Turn off the Spanning Tree Protocol.
remote setbroptions stp off PPPoEbridge
#
# Allow only PPPoE traffic through this remote.
remote setbroptions  pppoeonly on PPPoEbridge
#
# ------------------------------------------------------------
# Define a remote router entry (named PPPoEuser) to serve as
# the PPPoE client for connections to the service DialUpPPP.net.
remote add  PPPoEuser
remote setpppoeservice  DialUpPPP.net  PPPoEuser
#
# Turn off authentication of the remote router by the target router.
remote disauthen PPPoEuser
#
# Specify the CHAP user name and password required by the service.
remote setoursysname  JaneDoe  PPPoEuser
remote setourpasswd  Secret  PPPoEuser
#
# Define an IP route for the remote.
remote addiproute  0.0.0.0  0.0.0.0  1  PPPoEuser
#
# Turn on Network Address Translation for the remote.
remote setiptranslate  on  PPPoEuser
#
# Permanently allocate a channel for the connection.
remote setminline  1  PPPoEuser
# To have PPPoE sessions timeout after 10 min. (600 sec.) of no traffic,
# change the setminline value to 0 and add this command:
# remote settimer  600  PPPoEuser
#
```

```
# ------------------------------------------
# Save the configuration changes and then reboot.
save
reboot
```

Managing PPPoE Sessions

Each PPPoE session is listed with the other interfaces in the output from an ifs command. In the following example, the PPPoE session is shown as the last line of the output.

```
-> ifs
Interface   Speed       In %     Out % Protocol     State
Connection
ETHERNET/0 10.0.mb     0%/0%     0%/0% (Ethernet)   OPENED
DMT/0       8.0mb D    0%/0%           (ATM)        OPENED
            800kb U                0%/0% (ATM)        OPENED
ATM-VC/1    8.0mb D    0%/0%          (ATM)        OPENED   to
PPPoEbridge
            800kb U               0%/0% (ATM)        OPENED   to
PPPoEbridge
ATM-ECHO/2  8.0mb D    0%/0%           (ATM)        OPENED
            800kb U                0%/0% (ATM)        OPENED
CONSOLE/0  9600 b      0%/0%     0%/0% (TTY)        OPENED
PPPoE/1    10.0 mb     0%/0%     0%/0% (PPP)        OPENED   to
PPPoEuser
```

You can list more information about the current PPPoE sessions using the pppoe list command. The following is an example:

```
-> pppoe list
PPPoE Client Session ...... DialUpPPP.net
      PPPoE/Ifs number..... 1
      Access Concentrator.. 15021109931568-efficient
      Peer MAC Address .... 00:10:67:00:66:E2
      Session ID .......... 2
      State ............... 2
```

```
Flags ............... 1
```

To close a PPPoE session before it terminates, use the pppoe close command. The session is specified by its number. (Use the PPPoE/n number from the ifs output or the PPPoE/Ifs number from the pppoe list output.)

VPN

VPN (Virtual Private Network) is a term used to describe the connection between two or more private (or trusted) networks when the connection is carried across a public (non-trusted) network. A VPN will isolate the private traffic while it is on the public network so that the connection seems private.

A VPN can be created in many ways using many different technologies. In this section, we will briefly discuss the difference between physical (Layer-1), transport (Layer-2), and network (Layer-3) methods of creating a private network. Then we will discuss the protocols and equipment standards of a Layer-3 VPN.

Physical (Layer-1) VPNs

ISDN, analog dial-up

Most of us don't think of dial-up services as VPNs, but they have many of the same characteristics. For example, analog dial-up allows a user to connect to a private network (Corporate LAN) by using a public network (PSTN) as the transport.

Advantages

Accessible: The biggest advantage of using the PSTN is that the network reaches almost every location on the planet. Almost anyone can place a phone call to his/her data center because there are telephones all over the world. The network is established and accessible.

Connect to multiple sites: Using the PSTN allows a person to connect to multiple locations by simply dialing different phone numbers. It is very flexible.

Disadvantages

Long distance charges: If the locations being dialed are not local, then connection costs can get very expensive and run up a large bill quickly.

Data throughput limitations: The data throughput using the PSTN has limits due to the technology that is used to pass traffic. If high bandwidth is required, then analog or ISDN dial-up is not an option.

Transport (Layer-2) VPNs

Virtual Circuits

A Layer-2 VPN is typically an ATM or Frame Relay (FR) link over a high-speed DSL, T1, or a T3 line. With both of these protocols (ATM and Frame Relay), a dedicated line can actually be connected to multiple sites simultaneously by means of PVCs (Permanent Virtual Circuits). A PVC allows multiple dedicated (point-to-point) connections to exist over a single dedicated (physical) line.

ATM or Frame Relay transport

When using ATM or Frame Relay (FR) as the transport for network traffic, connections between two (or more) locations are managed with ATM switches. These switches make each PVC appear like a single point-to-point connection from one ATM router (or bridge) to another. Here again, the ATM network is a public network, and it is used to transport private network traffic.

Advantages

Higher bandwidth: ATM and FR are used as Layer-2 transport on higher speed physical connections. Generally, the lowest speed for FR connections are 56 Kbps dedicated. Speeds go up from there to well over 45 Mbps.

Permanent connections: Each PVC is permanently mapped through the ATM network from one LAN to another. This gives the perception that all of the local networks are connected together and are private.

Quality of Service: The quality of the network service can be guaranteed because of the nature of the ATM protocol.

Disadvantages

Expensive long haul: Connecting a PVC from one location to another will often incur “mileage” charges if the PVC endpoints are not within a few miles of each other.

Permanent connections: The PVC connections are indeed permanent and must be provisioned through the ATM network. Users cannot simply choose to call up another location when they want. This can be a problem if a company needs to add connectivity to multiple sites on a sporadic basis.

Expensive to install: Using permanent connections can be expensive to install, and may not be available in all locations. It requires a commitment to long term quality access from LAN-to- LAN through a WAN connection.

Network (Layer-3) VPNs

Tunneling

Tunneling has been in existence for many years and recently has become the answer to cutting long distance WAN access costs. This is what most of us think of as "VPN". Tunneling uses some Layer-1 and Layer-2 technology already in place. It also uses a public (or private) IP network to connect multiple sites together.

IP Network transport (public or private)

Using a public IP network to transport private LAN data would not have been practical had there not been public IP network on which to transport data. Since the Internet is a public IP network and is now accessible to a majority of users, it is now practical to use it as the transport mechanism for private data.

Advantages

CHEAP: The most compelling reason for using the Internet for a VPN is that it can cut long-distance charges dramatically. The common disadvantage of both Layer-1 and Layer-2 transport is the cost of long distance. Internet long distance is FREE!

Easy to set up: Both networks must have tunneling equipment, but once that is in place, connecting from one network to another is just like placing a phone call.

Flexible: Since it is not cost-prohibitive to install a new tunnel through the Internet, new locations can be brought online quickly.

Disadvantages

No Quality of Service guarantees: The quality of the transport is usually NOT guaranteed and we all know how the Internet can slow down at times. There can be latency and slow throughput if the Internet slows down.

Protocol support: TCP/IP protocol is well suited for running effectively on error-prone networks. However, protocols like Bridging, Appletalk, Novel IPX, and other LAN protocols do not perform well on a highly latent and error-prone network like the Internet.

Interpretability (standards): Current implementations of tunneling protocols are not highly interoperable between vendors due to the young age of the technology. However, there are several tunneling protocol standards that are settling in and this will not remain an issue for long. The standardized protocols for tunneling are IPSec and L2TP.

Technology Standards

IPSec

This protocol encrypts each IP packet that is destined for a tunnel and puts new header information on it to transport it to its destination. The new header information is what creates the "tunnel" effect. This protocol can create a tunnel and encrypt data, but only IP packets can be encrypted and transported. No other protocols are transported through the tunnel.

L2TP (Layer-2 Tunneling Protocol)

Cisco (L2F) and Microsoft (PPTP) agreed to standardize their two tunneling protocols by joining them into a common standard protocol. That protocol is L2TP. The L2TP protocol creates a tunnel between two endpoints and allows a PPP session to be created within it. The L2TP protocol manages the tunnel in a way that makes it transparent to the PPP session inside of it. L2TP clients are like "dial-up" users, and L2TP servers are like access concentrators (modem banks). Once the connection is "dialed", authenticated, and connected, data starts to flow through the tunnel in much the same manner as a modem dial-up, except that the call is placed through the Internet (IP network) instead of the PSTN (telephone network).

PPP (Point-to-Point Protocol)

PPP is used primarily for dial-up access right now because it allows for the dynamic negotiation of link parameters during the link establishment phase. This simplifies interoperability among dial-up devices. PPP provides the following benefits:

Authentication: Tunnel users can be authenticated, so that only authorized tunnel clients are accepted by the tunnel server.

Dynamic IP: An IP address can be dynamically assigned to the tunnel client when the tunnel is created. This conserves IP addresses because they can be issued out of a pool and recycled. PPP is currently used in this manner with dial-up users.

Multiple protocol support: Multiple LAN protocols (IP, IPX, Appletalk, and Bridging) can be transported on the same link.

Data and header compression: Van Jacobson header compression and STAC data compression can only be used in conjunction with PPP. Up to 5 times more data can be transferred by using compression.

DES Encryption

IPSec has encryption built into it, therefore, the data being transported is kept private while it is on the public Internet. L2TP does not encrypt the data as part of the tunnel management, so the data being transported in an L2TP tunnel must be encrypted before entering the tunnel. DES encryption is a United States Department of Defense standard for encryption that is widely deployed and comes in different strengths (40 bit, 56 bit, 128 bit, and triple DES). DES can encrypt any LAN protocol.

Tunnel Server

Function

The L2TP tunnel server receives tunnel "calls" and controls the tunnel once it is created. It is responsible for multiple tunnels simultaneously. The server can run as a service on a network server or as a stand-alone device on the network.

Location

The L2TP tunnel server is usually located at the edge of a LAN where it connects to the WAN. Generally, the tunnel server will be attached on both sides of the firewall. This allows tunnel traffic to access the tunnel server from the exposed WAN and be transported to the private LAN without going through the firewall. Sometimes tunnel servers are placed completely behind the firewall and only tunnel traffic is allowed through the firewall for access to the private LAN.

LAN-based Tunnel Client

Function

The LAN-based L2TP tunnel client initiates "calls" to the tunnel servers to which it needs to connect. Once the tunnel is established, the server takes control of the tunnel management. The L2TP tunnel client can be a stand-alone device or run as a service on a network server. This type of tunnel client must initiate calls to the tunnel server whenever LAN traffic needs to be forwarded and disconnect the call when the traffic stops. The LAN-based tunnel client manages the tunnel creation on behalf of the workstations on the LAN and is transparent to them.

Location

It is usually located on the boundary where the LAN and WAN meet, but it can reside anywhere on the LAN. This device can initiate calls, but cannot receive calls, so it can be located either inside of the firewall or across it.

Workstation-based Tunnel Client

Function

The workstation-based L2TP tunnel client initiates "calls" to the tunnel servers to which it needs to connect, but it can only support the workstation creating the tunnel. This type of tunnel client can only support one workstation unlike the LAN-based client which supports multiple workstations. This is software that runs on a workstation and is ideal for remote users who carry laptop computers and need access to the tunnel from different locations.

Location

This software is installed on the workstation for the purpose of creating a tunnel to a LAN.

Service Provider-based VPNs

Tunneling from a POP or access concentrator

VPN services can be provided to users by creating and terminating the tunnels at the Internet Service Provider (ISP) Point of Presence (POP) on the Internet. This allows dial-in users to place a normal call to the POP, which in turn creates a tunnel to a Corporate site. The tunnel is not created from the dial-up device, but instead from the device that receives that call. Before the data can get to the Internet, it is encapsulated into the tunnel and sent to the Corporate LAN.

Types of VPNs used

All of the technologies listed above are used to create these tunnels. The ISP might have a PVC connection to a Corporate site, or an L2TP tunnel, or even an IPSec connection. Whatever the choice, it is transparent to the end user. The user simply places the modem call to the ISP POP and logs onto the Corporate network.

Advantages

ISP manages the service: The end user uses traditional dial-up devices and is connected to the Corporate network. If it does not work, then the ISP has to fix the problem as part of the service.

ISP can offer a valuable service: The ISP can add value for the customer and sell a managed VPN service. This can be a win / win situation for both the ISP and the end user.

Dedicated access: This solution can work for dedicated access as well. The end user does not know if the data connection is running over ATM or L2TP once it leaves the customer premises. The ISP can use this in lieu of an ATM PVC.

Disadvantages

Workstation-client to LAN-server Service cost: The cost for the VPN service might be fairly high because it is a recurring monthly cost.

No Quality of Service guarantee: Asps do not offer any guarantees for the Quality of Service (QoS) on these accounts. QoS guarantees come with dedicated services only.

Limited mobile access: The user cannot dial into just any ISP and expect to be connected to the Corporate Network. There will be a limited number (and location) of POPs that will provide the desired access.

Workstation Client to LAN Server

Tunneling from a Workstation to a Server on the Enterprise LAN

This is a common approach to VPN. The workstations at the remote offices or homes have special software installed that allows them to connect to the tunnel server on the Corporate LAN. The connection is transparent to the Internet and each workstation is authenticated and managed independently on its own tunnel. Each workstation can have a different means of accessing the Internet (modem, LAN router, etc).

Types of VPNs used

Typically, only tunneling VPN solutions are used in this environment. It is used when there are a lot of mobile users who need to connect to the corporate office. All they need to do is have access to the Internet, and the software on the workstation will be able to connect to the Corporate LAN.

Advantages

Mobile access: Accessing the Corporate network is as simple as finding a phone to plug into and dialing the Internet. The user is not limited to any particular ISP or modem technology, but the workstation must have the tunnel client software installed and configured.

Do it yourself: This type of VPN can be installed and configured quickly. Then it can be easily added to when new users come online.

Disadvantages

Software must be installed on each workstation: Each workstation that accesses the Corporate LAN through VPN needs to have the tunneling software installed and configured on it. This can be a problem if the client software is not available for all operating systems. This can also be a problem if the workstation gets lost or stolen -- the thief can access the Corporate LAN.

Large number of tunnels to service: Since each workstation is its own tunnel, this can create a high volume of tunnels for the Corporate tunnel server to manage. It can also add to LAN traffic if LAN-based workstations are tunneling over the LAN on the way to the Corporate network.

LAN client to LAN server

Tunneling from LAN/WAN edge to LAN/WAN edge at Enterprise

Creating tunnels at the edge of a LAN, just before data leaves the trusted network, is a practical approach when the whole LAN needs to gain access to another LAN that is also attached to the Internet. This approach is ideal for small offices and telecommuters that do not require mobile access to the Corporate network.

Types of VPNs used

Both ATM PVCs and tunneling VPNs can be practical for LAN-to-LAN connections. If all of the LANs are local and the connections don't need to vary, then ATM might be the best solution. If even one location is far away from the others or if many different connection possibilities must be present, then tunneling makes more sense.

Advantages

Simultaneous connections to multiple sites: Multiple sites can be connected together using this VPN strategy because each LAN-attached tunnel device can connect to multiple locations.

Fewer tunnels to manage: By creating only one tunnel for each LAN, the number of tunnels that have to be managed is reduced.

No workstation software required: By creating a tunnel as the LAN data sent to the Internet, there is no need to create tunnels from each workstation and therefore no need to install special software on each workstation.

Cost: This solution can cost far less in equipment and management since it centralizes the tunneling functions on each LAN and is transparent to other devices on the LAN.

Disadvantages

Mobile users still need workstation software: Even with the LAN-to-LAN approach, mobile users still need to have software installed on their laptops if they wish to have access to the LAN.

Secure VPN Option

Secure VPN software has been designed to provide maximum flexibility and function.

Embedded system: Secure VPN software runs on the router without any additional hardware. It is a software-only upgrade.

Client AND server: Each router has the capability of being a tunnel client and a tunnel server simultaneously. If a call comes in, then the router will be a server. If a call needs to be placed outbound, then the router will be a client. When connecting two LANs together using L2TP, it is common for both networks to need a tunnel server and a tunnel client, so that they can place and receive tunnel calls.

Dial-on-Demand: Tunnels are created and destroyed dynamically based on network traffic and an inactivity timer. This allows multiple tunnels to be available, and only the required ones are active. Tunnels can be run with or without encryption.

Multiple protocols supported: IP routing, IPX routing, and bridging are supported to allow for Microsoft Networking, Novell networks and other non-IP protocols to function properly through the tunnel(s).

DES Encryption with Dynamic Key Exchange: When running an encrypted tunnel, the encryption keys are dynamically exchanged to make it almost impossible to expose the data.

Each tunnel is a virtual interface: All elements of NAT, DHCP, Firewall, routing, bandwidth thresholds, inactivity time-outs, etc. can be configured on a per-tunnel basis, and are independent "virtual" interfaces.

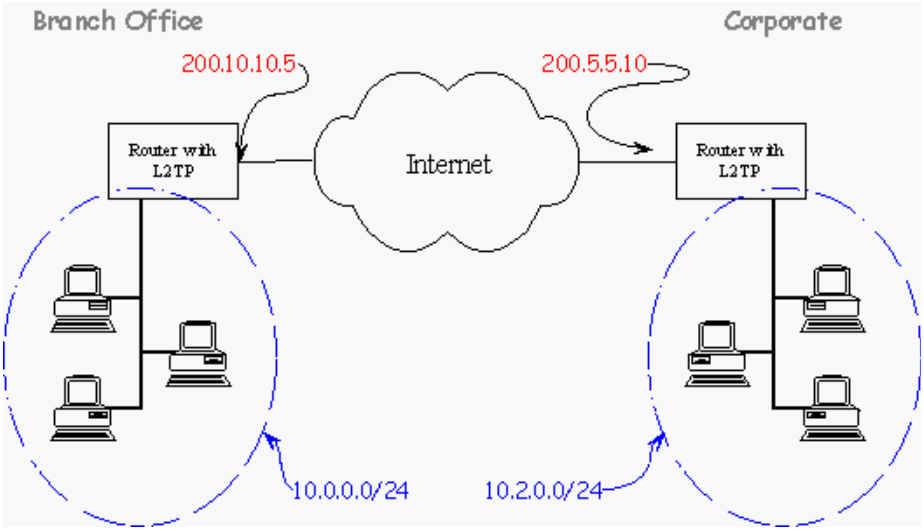
Secure VPN is ideally suited for "do-it-yourself" setup of LAN-to-LAN VPNs using existing remote access hardware. Tunneling, multi-protocol support, encryption, compression, flexibility, and a smart design will make you think that you are configuring a dial-up device.

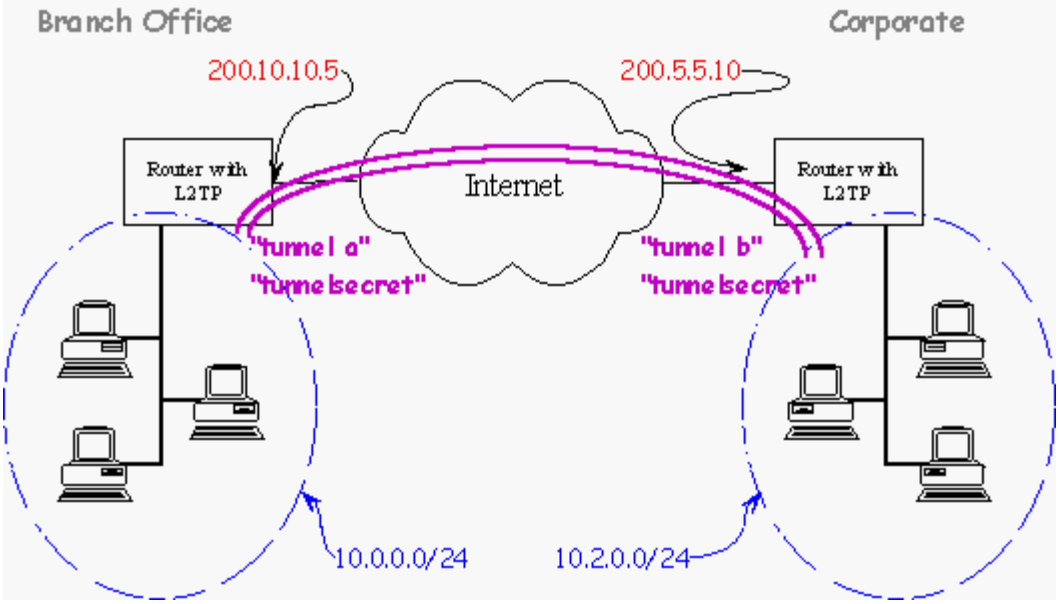
When it is necessary to connect several sites together with tunneling, there are two options:

- Set up a central tunnel server as the hub for all tunnel clients to communicate with other sites.
- Set up capability for each site to connect to all sites without going through a central server.

The latter will distribute the load of network traffic based on site requirements and connections will never suffer from a congested central server.

The following example describes how to configure two DSL routers for LAN-to-LAN connectivity using the Internet as transport. L2TP Tunneling is used to create a PPP session between the two WAN port IP addresses of the DSL routers. For data security, DES Encryption with Diffie-Hellman key exchange is used to encrypt the data that is sent into the L2TP tunnel. IP datagrams are routed between Corporate and Branch Office. Other protocols can be transported, but are not considered in this example. The diagram below depicts the setup.





Step 1: Configure Both Routers for Internet Connectivity

This configuration example assumes the routers are already configured to connect to the Internet. The configuration uses PPP for the link protocol and has IP routing only.

Branch Office Configuration:

This router has an IP address of 10.0.0.1 on the LAN and 200.10.10.5 on the WAN. NAT is on and it tunnels to another network (10.2.0.0). It is set as an L2TP Server and Client -- it can place a tunnel call to its peer or receive a call from a peer. The IP address of the peer tunnel device is 200.5.5.10.

☞ **NOTE:**

You cannot ping the tunnel endpoint, only the LAN behind it.

The eth ip addr 10.0.0.1 255.255.255.0 command sets the Ethernet address of the branch office router. You may not need to change this setting unless both LAN subnets of the VPN are identical. Each LAN of a VPN solution must be a unique subnet.

Corporate Configuration:

This router has an IP address of 10.2.0.1 on the LAN and 200.5.5.10 on the WAN. NAT is on and it tunnels to another network (10.0.0.0). This device is set as an L2TP Server and Client. It can receive a tunnel call from its peer or place a call to a peer. The IP address of the peer tunnel device is 200.10.10.5

☞ **NOTE:**

You cannot ping the tunnel endpoint, only the LAN behind it.

The eth ip addr 10.2.0.1 255.255.255.0 command sets the Ethernet address of the corporate router. You may not need to change this setting unless both LAN subnets of the VPN are identical. Each LAN of a VPN solution must be a unique subnet.

Step 2: Configure the L2TP Tunnel Connections

Branch Office Configuration:

Set up the tunnel to Corporate with:

```
l2tp add tunnelb
```

The name "tunnelb" is the name that is expected from the tunnel peer when challenged to identify itself. The Branch Office router asks "Who are you?" and Corporate says "I am tunnelb" and the Branch Office authenticates. This command must match the Corporate router name in the command:

```
l2tp set ourtunnelname <name> <tunnel name>
```

Next, define the common authentication secret used between the two devices. This tunnel device will use the password of "tunnelsecret" for the tunnel peer when challenged to identify itself. Both peers use the same secret:

```
l2tp set chapsecret tunnelsecret tunnelb
```

Define the name of the our end of the tunnel for authentication purposes. The name "tunnela" is sent to the tunnel peer when challenged to identify yourself. Corp says "who are you" Branch replies "I am tunnela" Corporate authenticates. This setting must match the command "l2tp add <name>" on the Corporate router.

```
l2tp set ourtunnelname tunnela tunnelb
```

Define the sysname of this router for authentication purposes. This tunnel device sends the name "cust" when challenged to identify itself. This must match the command "remote add <name>" on the Corporate router.

```
l2tp set oursysname cust tunnelb
```

Define the password of this router for authentication purposes. This tunnel device sends the password "custpass" when challenged to identify itself. This must match the password in the command "rem setpasswd <password>" on the Corporate router.

```
l2tp set ourpassword custpass tunnelb
```

Set the IP address of the other end of the tunnel, that is, the WAN IP address of the Corporate router.

```
l2tp set address 200.5.5.10 tunnelb
```

Set LAC and/or LNS. In this case, both will allow this router to establish and receive a tunnel.

```
l2tp set type all tunnelb
```

Add the remote profile for the IP network on the other end of the tunnel. This name must match the name in the command "l2tp set oursysname <name> <tunnelname>" on the Corporate router.

```
remote add corp
```

Define the authentication password expected for this PPP link. This must match the password used in the command "l2tp set ourpassword password> <tunnel name>" on the Corp router.

```
remote setpasswd corppass corp
```

Define the other tunnel device as the LNS. This must match the tunnel name in the command "l2tp add <tunnel name>" on the Branch router. This links the l2tp settings to the remote settings for this tunnel profile.

```
remote setlns tunnelb corp
```

Set authentication to CHAP for the PPP link.

```
remote setauthen chap corp
```

Add an IP route to the LAN on the other end of the tunnel PPP link, a route must be added for each subnet that exist on the Corp LAN.

```
remote addiproute 10.2.0.0 255.255.255.0 1 corp
```

```
save
```

```
reboot
```

Corporate Configuration:

Set up the tunnel to the Branch Office. The name "tunnela" is the name that is expected from the tunnel peer when challenged to identify itself. Corporate asks "Who are you?" and Branch Office says "I am tunnela" and Corporate authenticates. This setting must match the command "l2tp setourtunnelname <name> <tunnelname>" on the Branch Office router.

```
l2tp add tunnela
```

Define the common authentication secret used between the two routers in the VPN. This tunnel device will use the password of "tunnelsecret" for the tunnel peer when challenged to identify itself. Both peers use the same secret.

```
l2tp set chapsecret tunnelsecret tunnela
```

Define the name of our tunnel for authentication purposes. This tunnel device sends the name "tunnelb" when challenged to identify itself by the tunnel peer. Branch Office asks "Who are you?" and Corporate says "I am tunnelb" and Branch Office authenticates. This setting must match the name in the command "l2tp add <name>" on the Branch Office router.

```
l2tp set ourtunnelname tunnelb tunnela
```

Define the sysname of this router, for authentication purposes. This tunnel device sends the name "corp" when challenged to identify itself. This setting must match the name in the command "remote add <name>" on the Branch Office router.

```
l2tp set oursysname corp tunnela
```

Define the password of this router for authentication purposes. This tunnel device sends the password "corppass" when challenged to identify itself. This must match the password in the command "rem setpasswd <password>" on the Branch Office router.

```
l2tp set ourpassword corppass tunnela
```

Set the IP address of the other end of the tunnel, that is, the WAN IP address of the Branch router.

```
l2tp set address 200.10.10.5 tunnela
```

Set LAC and/or LNS. In this case both, this will allow this router to establish and receive a tunnel.

```
l2tp set type all tunnela
```

Add the remote profile for the IP network on the other end of the tunnel. This must match the name in the command "l2tp set oursysname <name> tunnel name>" on the Branch Office router.

```
remote add cust
```

Define the authentication password expected for this PPP link. This must match the password used in the command "l2tp set our password <password> <tunnel name>" on the Branch Office router.

```
remote setpasswd custpass cust
```

Define the other tunnel device as the LNS. This must match the tunnel name in the command "l2tp add <tunnel name>" on the Corp router. This command ties the l2tp settings to the remote settings for this tunnel profile.

```
remote setlns tunnela cust
```

Set authentication to CHAP for the PPP link.

```
remote setauthen chap cust
```

Add an IP route to the LAN on the other end of the tunnel PPP link. A route must be added for each subnet that exists on the Branch Offfice LAN.

```
remote addiproute 10.0.0.0 255.255.255.0 1 cust
save
reboot
```

Step 3: Configure Encryption and Key Exchange

Branch Office Configuration:

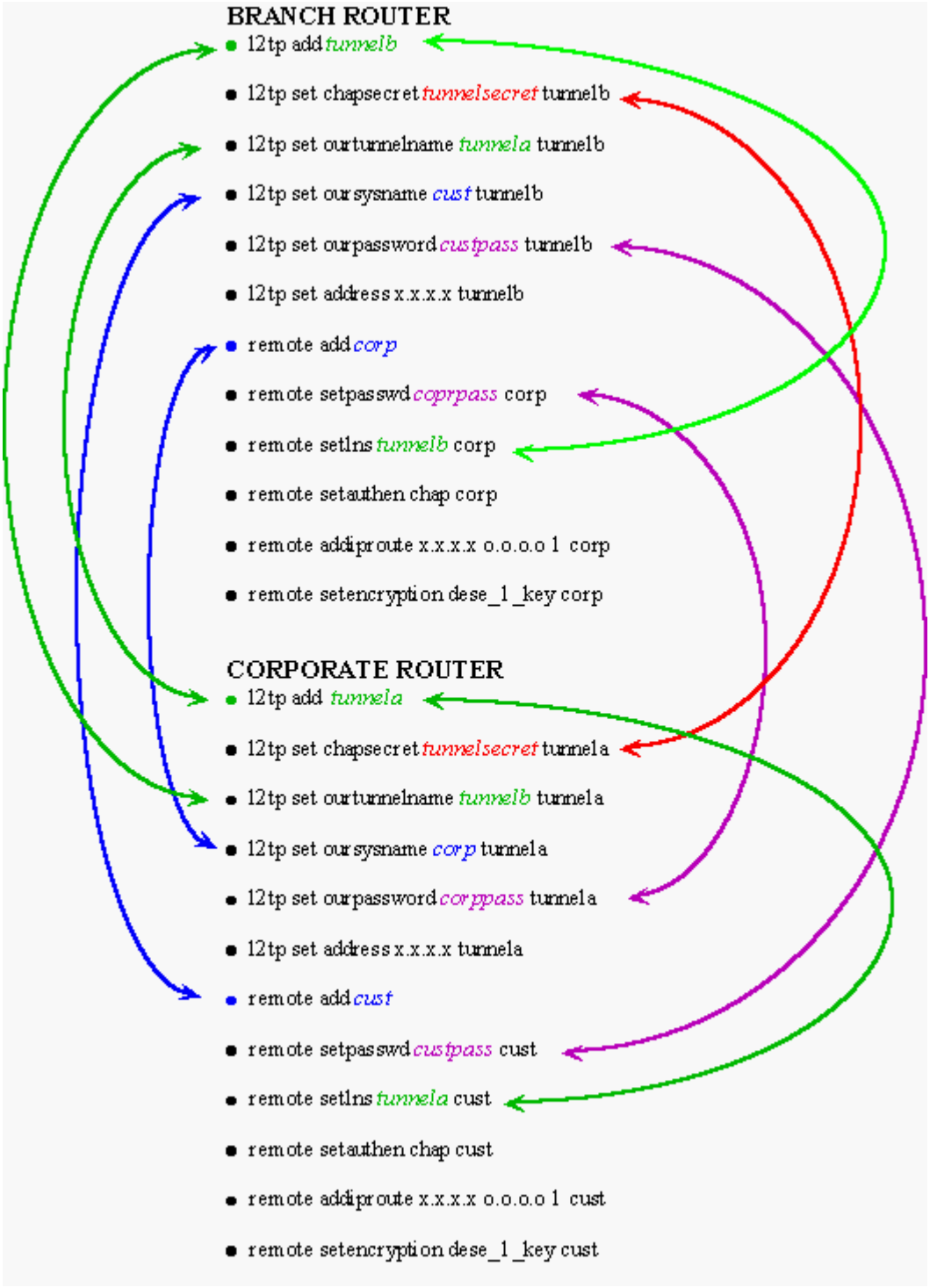
Enable encryption on the PPP link that goes through the tunnel.

```
remote setencryption dese_1_key corp
save
reboot
```

Corporate Configuration:

Enable encryption on the PPP link that goes through the tunnel.

```
remote setencryption dese_1_key cust
save
reboot
```


BRANCH ROUTER
l2tp add funnelb
l2tp set chapsecret funnelsecret tunnelb
l2tp set ourtunnelname funnela tunnelb
l2tp set oursysname cust tunnelb
l2tp set ourpassword custpass tunnelb
l2tp set address x.x.x.x tunnelb
remote add corp
remote setpasswd coprpass corp
remote setlns funnelb corp
remote setauthen chap corp
remote addiproute x.x.x.x o.o.o.o 1 corp
remote setencryption dese_1_key corp
CORPORATE ROUTER
l2tp add funnela
l2tp set chapsecret funnelsecret tunnela
l2tp set ourtunnelname funnelb tunnela
l2tp set oursysname corp tunnela
l2tp set ourpassword corppass tunnela
l2tp set address x.x.x.x tunnela
remote add cust
remote setpasswd custpass cust
remote setlns funnela cust
remote setauthen chap cust
remote addiproute x.x.x.x o.o.o.o 1 cust
remote setencryption dese_1_key cust

VPN with IP Filtering and MS Networking

When setting up Secure VPN and Firewall functions, the configuration of routers is not complete until each user can log onto the corporate domain controller for access to all resources on the LAN. UDP relay and WINS server commands will allow MS networking to function through a VPN tunnel. The following items must be configured:

1. Domain controller must be configured for networking using IP.
2. Client workstations must be configured for networking using IP.
3. A router must have UDP relay configured.
4. A router must be configured to serve the primary and secondary WINS server IP addresses.
5. A firewall must accept packets to and from the IP address of the far end.

For instructions on items 1 and 2, consult a Windows manual. A script for items 3, 4, and 5 appears below.

system addudprelay *<server IP address> <first port> <last port>*

e.g. system addudprelay 192.168.254.50 137 139

dhcp set valueoption *44 <prim winsserv ip address> <secondary>*

e.g. dhcp set valueoption 44 192.168.254.50 192.168.254.60

remote ipfilter *insert input accept -sa < IP address of far end> <remote name>*

remote ipfilter *insert output accept -da < IP address of far end> <remote name>*

remote ipfilter *insert input accept -sa 200.x.x.x internet*

remote ipfilter *insert output accept -da 200.x.x.x internet*

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CHAPTER 7

MONITORING SYSTEM PERFORMANCE

This chapter discusses the tools available to monitor and troubleshoot the router's operation as well as survey network functions.

Syslog Client

The router can act as a Syslog client, automatically sending system event messages to one or more Unix Syslog servers. (For example, if you request an IP filter watch, the messages are sent to the Syslog servers; see the eth ip filter command.) Messages generated by the router and sent to a Syslog server are sent to facility local0 with priority notice.

To send messages to Syslog servers, the router must know:

- The Syslog port number, and
- The IP address(es) of the Syslog servers.

To disable, re-enable, or redefine the Syslog port, use the system syslogport command.

The router can learn the IP addresses of Syslog servers in two ways:

- Via DHCP. The router can, under certain circumstances, send out a DHCP message and learn the IP address(es) of Syslog servers. For more information, see "DHCP Client Requests" on page 4-3.
- By explicit configuration. To configure the IP address of a Syslog server, use the system addsyslogserver command.

You can limit the Syslog server addresses that the router learns through DHCP. To do so, set a filter for valid Syslog server addresses using the system addsyslogfilter command.

SNMP

The Simple Network Management Protocol (SNMP) is a member of the TCP/IP protocol suite designed to provide network management interoperability among different vendors' management applications and equipment. SNMP provides for the exchange of messages between a management client and a management agent. The message contains requests to get and set variables that exist in network nodes, thus allowing a management client to obtain statistics, set configuration parameters, and monitor events. These variables (or objects) are defined in Management Information Bases (MIBs), some of which are general or standard SNMP bases. Other bases, Enterprise specific MIBs are defined by the different vendors for specific hardware. Communication with the SNMP agent occurs over the LAN or WAN connection.

Any management application using SNMP over UDP/IP has access to the local SNMP agent. SNMP network management tools vary but often have features to display network maps of SNMP nodes, poll nodes at intervals, trigger alarms on thresholds, graph or list node statistic counters, view and edit individual MIB variables, and print reports.

An example of useful information that can be obtained from a remote SNMP client would be the current status of the router's WAN link and Ethernet interfaces, including protocol (PPP, CSMA-CD), line speed, maximum frame (transmission unit) size, physical address, operating status, or packet traffic rates.

MIBs

The MIB is collection of database objects that the system maintains and provides to the SNMP manager upon request. The supported MIB group or subset, and a description of their contents are listed in the following table.

Table 7-1: Supported MIBs

Group	Definition
System Group	This group provides a description of the system. It include the full name and version identification of the system's hardware type, software operating-system, and networking software.
Interfaces Group	This group provides information on the system's interfaces.
Address Translation Group	This group provides information for converting a Network Address into a subnetwork-specific address.
Ethernet Group	This group provides information for the Ethernet Port.
IP Group	This group provides information for the IP interface of the system.

Table 7-1: Supported MIBs

Group	Definition
ICMP Group	These groups provide connection, status, and statistical information for each of the protocols of the system.
TCP Group	
UDP Group	
SNMP Group	
ATM Group	This group provides information for ATM Physical Layer.
Bridge MIB	State and statistical information within the bridging system.
Enterprise MIB	Router-specific objects for configuration purposes.

Trap Generation

SNMP agents also have the ability to send (unrequested) messages to SNMP managers; these messages are called traps and notify the SNMP managers that an event has happened on the system. The SNMP Traps generated by the router are:

- coldstart - indicating that the system has be initialized
- warmstart - indicating that the system has be re-initialized (LES EOC only)
- link up - indicating that the WAN link has been established
- link down - indicating the WAN link has been dropped
- insufficient physical bandwidth - indicating the physical layer bandwidth has dropped below the configured AAL2 VC bandwidth
- excess impairment - indicates the number of impairments on a voice port has exceeded the CPIWF Impairment threshold

Configuring SNMP

The router provides SNMP agent support for accepting SNMP requests for status, statistics, and configuration information as read-only operations and remote configuration (write-operations) by an SNMP manager is allowed after authentication. The SNMP configuration parameters are described in the following paragraphs.

- **Community String** - This parameter identifies the SNMP community to which the router belongs. The community acts as a identifier between the SNMP manager and agent for requests. The community setting allows the SNMP manager to request information from a *community*, rather than each node (agent) individually. By default, the community is set to *public*; a commonly used string. The router supports association of one community setting.
- **SNMP Port** - Allows management of the SNMP port. The SNMP port can be disabled, set to the default (161) or re-defined to a non-standard value.
- **SNMP Interfaces** - This parameter defines SNMP participation by interface by enabling or disabling WAN or LAN access.
- **System Password** - This is the password used by all client based support applications.
- **Trap Manager** - The IP address for a node (SNMP manager) that will receive a Trap event from the router. Up to four Trap Manager entries can be configured. The Trap Manager is an optional setting and can be enabled or disable as desired.
- **SNMP Filter** - The SNMP filter validates SNMP clients by defining a single or range of IP addresses that are allowed to access the router via the SNMP. Multiple address ranges can be specified; if no range is specified, access is allowed as defined in the SNMP interfaces setting.

Procedures

To configure SNMP parameters via the WMI, refer to ‘SNMP” on page 8-41. To configure SNMP from the command line, use the following commands:

```
-> snmp community <snmp community name>
```

Sets the SNMP community to which the router belongs; the default community is "*public*".

```
-> snmp snmpport  default | disabled | <port>
```

Default - Returns the SNMP port the default value(161) and re-enables SNMP after it is disabled.

Disabled - Disables the SNMP port by setting the port to 0).

Redefines the SNMP port. to a value between 1 and 65535.

```
-> snmp snmppasswd <password>
```

Sets the SNMP password.

```
-> snmp addtrapdest <ipaddr>
```

```
-> snmp deltrapdest <ipaddr>
```

Commands to creates or delete trap manager entries.

```
-> snmp settrapenable on | off
```

Enables and disables trap message transmission.

```
-> snmp addsnmpfilter <first ip addr> [<last ip addr>] | lan
```

```
-> snmp delsnmpfilter <first ip addr> [<last ip addr>] | lan
```

Commands to creates or delete the client range for SNMP access.

```
-> snmp enablesnmpif wan | lan
```

```
-> snmp disablesnmpif wan | lan
```

Enables and disables SNMP access from the specified interface.

The following command will display the current SNMP configuration information. An example is shown below.

```
-> snmp list
```

```
SNMP CONFIGURATION INFORMATION
    Community name..................... iads
    Port............................... default (161)
    IF Enabled......................... LAN only
    Clients............................ all
    Global Trap Enable................. on
    Configured Trap Destinations......... none
```

Troubleshooting

Software problems usually occur when the router's software configuration contains incomplete or incorrect information. This section discusses:

- Diagnostic tools that are available to help identify and solve problems that may occur with your router.
- Symptoms of software configuration problems
- Actions for you to take
- System messages

Diagnostic Tools

This section describes three diagnostic tools available to you:

- The LEDs on the front panel of your router.
- The History Log that lists the router's activity.
- The ping command that can verify IP connectivity.

Using LEDs

The specific pattern of LEDs on your router model are described in the User Reference Guide that came with the router. Certain hardware problems can be diagnosed and solved by checking the LEDs.

For the LED patterns that indicate fatal boot errors, see "Identifying Fatal Boot Failures" on page 4-40.

LED Startup Sequence

The normal LED startup sequence involves the LEDs labeled PWR (power), TEST (self-test indicator), and LINK (modem link).

If the Power (PWR) LED is off:

- Check that the power cord is firmly plugged into the back panel of the router and the other end into an active AC wall or power-strip outlet.
- Check that the power switch is turned on.

The following table summarizes the normal LED sequence in the left column (five consecutive states) from Power On to Ready State. The right column suggests problems reflected by an "abnormal" LED state (no progression to the next state).

Table 7-2: LED State Sequence

State	Normal Sequence	Duration	Problem If the LED sequence stops at this stage
State 1 Power ON	PWR - green TEST - amber LINK or WAN - off	5 Sec.	A hardware problem has been detected. Contact Technical Support.
State 2	All lights flash	1 Sec.	
State 3	PWR - green TEST - green LINK or WAN - off	5 Sec.	1. Check that the DIP switches are all up. 2. Check that the correct software was loaded.
State 4	PWR - green TEST - green LINK or WAN - amber (no signal) blinking amber (signal) blinking green (training)	5 - 10 Sec.	1. Check your DSL cable. 2. Check the physical connection from your router to the DSLAM (Central Office). 3. Possible problem with DSLAM card.
State 5	PWR - green TEST - green LINK or WAN - green	Ready state	

LEDs in Ready State

Once the router is in Ready State, the LEDs may blink as follows:

- The TEST LED blinks every two seconds (heartbeat) to show that the router remains ready and active.
- The LINK or WAN LED blinks to indicate that the WAN is transmitting.
- If present, the LANT LED blinks to indicate that the Ethernet LAN is transmitting.
- If present, the LANR LED blinks to indicate that the Ethernet LAN is receiving.

If the normal “heartbeat” of the TEST LED stops, it indicates that the router is locked up and you need to cycle power to reset it.

To read about SDSL router LEDS, see SDSL Line Activation.

History Log

The History Log utility is a troubleshooting tool which displays the router's activity. It can be accessed from a terminal emulation session or from Telnet.

To see message explanations, refer to the System Messages section.

Accessing History Log through Telnet

Step 1 Click **Connect** and then **Remote System**.

Step 2 Enter the router's **IP address**.

Step 3 Click **Connect**.

Task Complete

Other Logging Commands

If you wish to monitor your router activity at all times, use the command system log start to view a continuous log, using Telnet. (This command will not work in a Terminal Window session; it only works from Telnet.)

The command system log status is used to find out if other users, including yourself, are using this utility.

To discontinue the log at the console, use the command system log stop.

When you exit Telnet, you automatically stop any logging programs running in that session.

☞ **NOTE:**

History Log is preserved across reboots, but not across power outages or power down.

Investigating Hardware Installation Problems

When investigating a hardware installation problem, first check the LEDs on the front panel of the router. Many common hardware problems can be easily diagnosed by the LED indicators. For more information, refer to this chapter's section entitled 'Using LEDs" on page 7-6.

If the terminal window display has a problem:

- Ensure your console is plugged in and turned on.
- Verify that you are on the right communications port (Com1, Com2).
- Check the configuration parameters for speed, parity, etc. Make sure the console is not in an XOFF state. Try entering a “ctrl q”.

Verify that the RS232 device attached to the console is configured as a DTE. If not, a crossover or null modem adapter is required.

If the factory configuration has a problem:

- Compare the router configuration with your router order.
- Verify that the model number is correct (the number is displayed during the boot procedure). The model number and serial number are also displayed on the main window of Configuration Manager.

Investigating Software Configuration Problems

This section suggests what to do if you cannot:

- connect to the router
- access the remote network
- access the router via Telnet
- download software

It then gives trouble-shooting advice for:

- Telephony services (if you have a VoDSL router)
- L2TP tunnels
- Dial Backup

Connection Problems

If you cannot connect your PC to the target router for configuration:

- For a LAN connection, verify that the router's IP address matches the IP address previously stored into the router's configuration. You must have previously set the router's Ethernet LAN IP address and subnet mask, saved the Ethernet configuration changes, and rebooted the router for the new IP address to take effect.
- Check that your LAN cable is pinned correctly and each pin end is securely plugged in.

Note: *If you are using a straight-through cable, the colors for pins 1, 2, 3, and 6 should match on both connectors. If you are using a crossover cable, the colors for pins 1, 2, 3, and 6 on one connector should match respectively 3, 6, 1, and 2 on the other connector.*

- Make sure the PC and target router are on the same IP subnetwork or the target router is reachable through a router on your LAN. They can, however, be on different networks if IP routing is off.
- Check Network TCP/IP properties under Windows 95 and the control panel of the TCP/IP driver installed under Windows 3.1.
- Check if the LAN LED on the router's front panel blinks when "pinged".
- Check your Ethernet board IRQ settings: the PC's table may have become "confused". If so, reboot your PC.

Remote Network Access Problems

Bridging

- Make sure to reboot if you have made any bridging destination or control changes.
- All IP addresses must be in the same IP subnetwork (IP is being bridged).
- Check that a bridging default destination has been configured and is enabled.
- Be sure to reboot if the bridging destination or status has been changed.
- Check that bridging is enabled locally (use the remote listbridge command).
- Verify that bridging is enabled by the remote router (use the command remote list).
- Verify that the Authentication Passwords are correct.
- Reboot your PC if you have Windows for WorkGroups.
- In Windows 95, do not forget to declare shared disk directories. Check the sharing properties on your C: drive.
- In the Terminal Window, check that calls are answered from the remote router.
- Check also for any PAP/CHAP errors for the remote router.

TCP/IP Routing

- Check that Ethernet LAN TCP/IP Routing has been enabled (eth list command).
- The IP addresses of the local and remote networks belong to different IP subnetworks.
- Make sure that there is an existing route to the remote network.
- Make sure that there is a route back from the remote network.
- There must be a source WAN IP address defined if you are using NAT.
- Check that, if required, the source and remote WAN IP addresses are on the same subnetwork
- Reboot if you have made any IP address or control or protocol option changes.
- Check that the IP address of the station/network connected to the LAN beyond the remote router is correct, as well as the associated subnet mask.
- If the remote router WAN IP address and subnet mask are required, check that they have been specified correctly.
- Check that a default route has been specified, if needed.
- Be sure to reboot if IP addresses or control or protocol option changes have been made.
- Check that you are using an Ethernet cable.
- Check that IP routing is enabled at both ends.
- The IP address must be within the valid range for the subnet.
- Verify that the IP and gateway addresses are correct on the PC.
- Windows 95 may remember MAC addresses: if you have changed MAC addresses, reboot the router and the PC.
- In Windows 3.1., check that the TCP driver is installed correctly. Ping (ping command) your PC's IP address from the PC. Successful "pinging" results let you know that the TCP driver is working properly.
- If you have changed an IP address to map to a different MAC device, and ping or IP fails, reboot your PC.
- Use the iproutes command to verify which router's name is the default gateway (this cannot be 0.0.0.0).

IPX Routing

- Check that IPX routing has been enabled and that the remote end is enabled for IPX routing.
- Validate that the IPX WAN network number matches the remote router's WAN network number.
- Check that IPX SAPs correctly identify the servers and applications on the remote network and have valid network numbers, node numbers, etc.
- Check that every SAP has a router to its internal network.
- Check that the IPX routes (network numbers, hops, and ticks) seeded into the routing table for network segments and servers beyond the remote router are correct.
- Validate that the IPX WAN network number matches the remote router's WAN network number.
- Check that the IPX routes (network numbers, hops, and ticks) seeded into the routing table for network segments and servers beyond the remote router are correct.
- Check that IPX SAPs correctly identify the servers and applications on the remote network and have valid network numbers, node numbers, etc.
- Be sure to reboot if IPX addresses, routes, SAPs or control has been changed.
- If the router fails to negotiate IPX:
  - Make sure that at least one WAN number is not equal to zero at one end of the link.
  - The server must have an IPX route to the remote LAN.
  - The Novell server needs to have burst mode turned on.
  - Large Internet packets have to be turned on.
- For Novell 3.12 and later:
  - Client needs VLM.EXE, net.cfg: large Internet packets=ON, Pburst=5
- If you can't see the server SAPs:
  - Check the frame types using the eth list command and ensure that they are the same on both routers.
  - Check that the Ethernet cable is correctly plugged in.
  - Make sure that the Novell server is up.

Incorrect VPI/VCI (ATM Routers)

If you are given an incorrect VCI/VPI number or none at all to use for the remote, and you need to determine what the possible value might be, use the atom findpvc command.

Telnet Access Problems

- Ensure that the router has a valid IP address.
- Check that the Ethernet cable is plugged in.

Software Download Problems

- Ensure that a TFTP server is properly set up to locate the router software.
- Verify that the router is loading from the network and not from FLASH memory.

Voice Routing (VoDSL) Troubleshooting

After the router WAN link activates (the WAN or LINK LED is green), you should get a dial tone. The dial tone should be received even if you have not yet configured your IP and bridge network settings.

If you do not get a dial tone, check the following:

- Does the router have power?
- Is the local phone cord plugged in?
- Is the voice PVC set correctly in the router? (See the following debug commands.)
- Is the WAN link down? (The WAN or LINK LED should be solid green.)
- Is the DSLAM provisioned for the second PVC?
- Is the voice gateway connected and provisioned? (If Coppercom or ATM Standards-based gateway is down or not communicating with the IAD, you hear dead air.)
- Is the ATM network down between the DSLAM and the voice gateway?
- Is provisioning for loop start or ground start correct? For ground start, tip and ring may be reversed in the RJ11 cable.

If you get a call treatment tone (tritone or 3-stage tone, Voice LED is amber), check the following:

- Voice PVC is not set in the router or is incorrect.
- WAN link is down (WAN or LINK LED should be solid green when link is up).
- DSLAM is not provisioned for the second PVC.
- Voice gateway is not connected or provisioned (Jetstream and Tollbridge gateways).
- ATM network is down between the DSLAM and voice gateway.

If you hear clicking during heavy data downloads, check that the DSLAM supports quality of service (QoS) and that the ATM switch has the voice PVC provisioned for vRT and the data at a lower priority. You may also be able to reduce or eliminate clicking by adjusting the jitter buffer (see “Adjusting the Jitter Buffer” on page 10-4..)

The Port Monitor GUI program can show you the voice PVC and the last event message. Use the Web GUI to verify the VPI/VCI or DLCI numbers for the data and voice connections. Also check loop start (standard phone set) or ground start. These values must match your Network Service Provider’s values.

L2TP Tunnel Troubleshooting

If you have problems setting up an L2TP tunnel, use the sample L2TP CLI file, l2_lac.txt, on the installation CD as your model and edit it to fit your situation.

Enter these commands at the client end (remote telecommuter):

```
# Define a remote named lnsserver

remote del lnsserver

remote add lnsserver

remote disauthen lnsserver

remote setoursysname lacclient lnsserver

remote setourpasswd clientpassword lnsserver

remote setLNS tunnelAtWork lnsserver

remote addiproute 192.168.100.0 255.255.255.0 1 lnsserver

# Set up a tunnel named tunnelAtWork

l2tp add tunnelAtWork

l2tp set chapsecret tunnelsecret tunnelAtWork

l2tp set ourtunnelname tunnelAtHome tunnelAtWork

l2tp set address 192.168.110.1 tunnelAtWork
```

Enter these commands at the LNS end (corporate site) for each teleworker:

```
# Define a remote named lacclient for the tunnel

remote del lacclient

remote add lacclient

remote setpass clientpassword lacclient

remote setLAC tunnelAtHome lacclient
```

```
remote setauthen chap lacclient
remote addiproute 192.168.101.0 255.255.255.0 1 lacclient
# Define a tunnel named tunnelAtHome.
l2tp del tunnelAtHome
l2tp add tunnelAtHome
l2tp set chapsecret tunnelsecret tunnelAtHome
l2tp set ourtunnelname tunnelAtWork tunnelAtHome
```

CHAPTER 8

WEB MANAGEMENT INTERFACE

The Efficient Networks router family provides two user interfaces methods: a Web Management Interface (WMI) that is web-browser (HTTP) based and a console type Command Line Interface (CLI). This section provides the an overview on how to use the browser based interface. For further information on the console-based interface, refer to the Command Line Interface Guide co-located on this Documentation CD.

Organization

The Graphical User Interface is organized within three primary elements:

- Menu Area - Provides access to feature specific content and configuration pages.
- Content Frame - The Content Frame is where all configuration and primary content is displayed.
- Banner - Area spanning the top of the WMI pages.

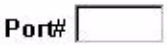
Accessibility

The Web Management Interface is accessible through most HTML browsers, though Internet Explorer 4.0 or Netscape 4.0 and higher are recommended.

User Interaction

Within the GUI, several different types of objects are employed to manage the system. These objects are described below.

Object		Description
Button		Buttons are used for event action. The button will be labeled with the action taken when clicked.
Pull-down Menu		Pull-down menus provide a list of fixed definition options for a specific parameter. The current value for the parameter is normally shown when the form is initially displayed. The list is activated by clicking the arrow and selection is made by clicking the desired option.

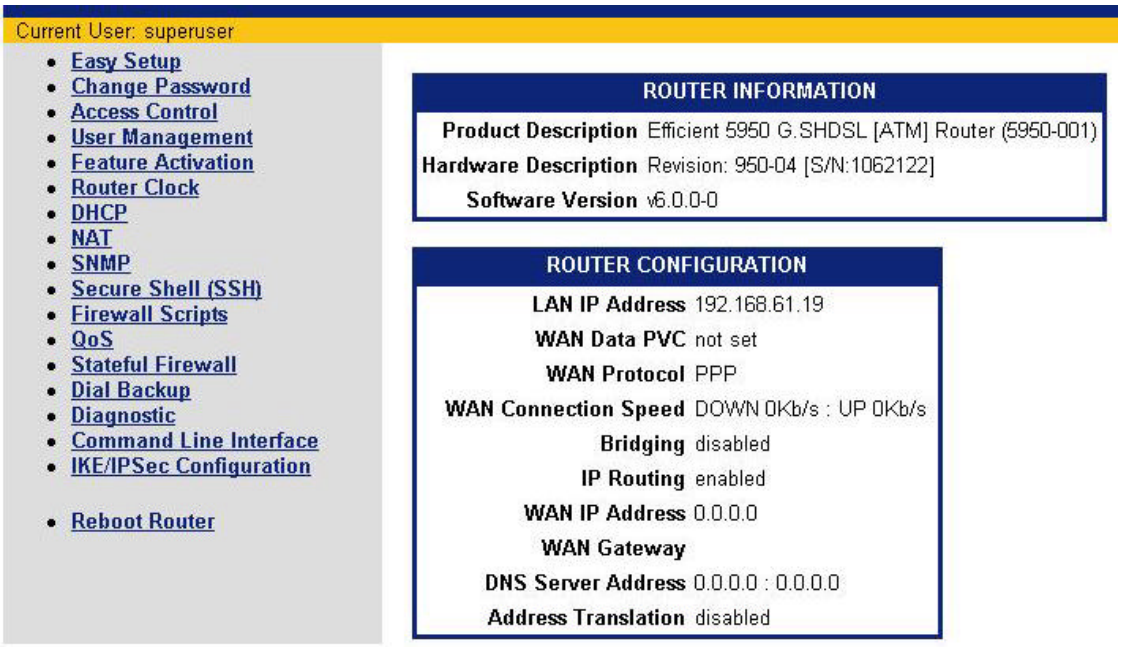
Object		Description
Radio Button		Radio buttons are used to select a single parameter from a list of parameters when only one may be selected. When a radio button is selected, it will usually deselect the previous selection.
Checkbox		Check boxes are used to select or de-select a single item. The item is usually from a set of parameters where more than one selection is allowed. The item is selected/de-selected with alternating clicks on the box. A check in the check box indicated the item is selected.
Text Field		A field that required ASCII character content entered through the keyboard. The parameter may require dotted-decimal notation entries.
Scroll Bars		Scroll bars are used to access information that is contained on a form that is beyond the viewable area. The scroll bars may appear vertically or horizontally. To view the un-displayed area, click the arrow and the page will scroll in the direction indicated.

Router Information Page

The primary page in the Web User Interface is the Router Information page. This screen displays basic router information and router configuration settings. It also provides links to other router setup and control forms. On the Router Information page, the following information is presented:

- Router Information - Including the model number, software version number and options that have been enabled.
- Router Configuration - Displays router configuration details such as LAN IP address, WAN data and voice PVC (ATM), WAN protocol and WAN network settings.

The following is a typical Router Information page:



Easy Setup

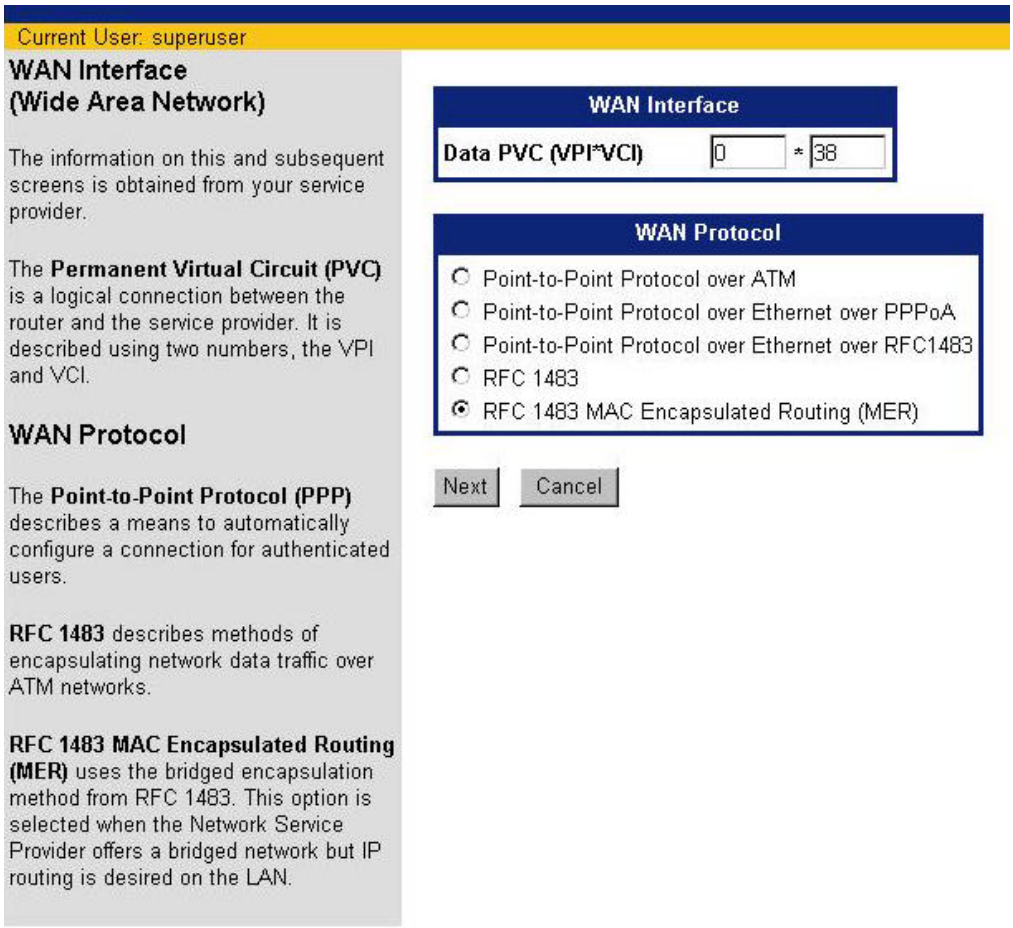
The Easy Setup screens are designed to provide an easy step-by-step configuration of the Wide Area Network (WAN) and Local Area Network (LAN). The information required for completing these forms is obtained from your service provider. A broader overview of the configuration parameters can be found in Chapter 3, Installation and Setup. Specific instruction for your router may vary. Refer to your User Reference Guide (located on this Documentation CD) for additional information.

Navigation to Easy Setup is shown below.

Easy Setup Navigation
From the Main Menu, select: > Easy Setup

Protocol Selection Page

The initial Easy Setup screen is for entering the reviewing information about Wide Area Network (WAN) settings.



On the *Protocol Selection* page, begin the Easy Setup procedure by performing the following:

☞ **NOTE:**

The Easy Setup procedure can be exited at any time during the configuration by clicking **Cancel**. If the procedure is cancelled, no changes will be made and the WMI will return to the Router Information Page.

Step 1 Enter the ATM Permanent Virtual Circuit (PVC) information: ***VPI*** / ***VCI***.

Step 2 Click the **radio button** to select the applicable ***WAN Protocol***.

Step 3 Click **Next** to continue.

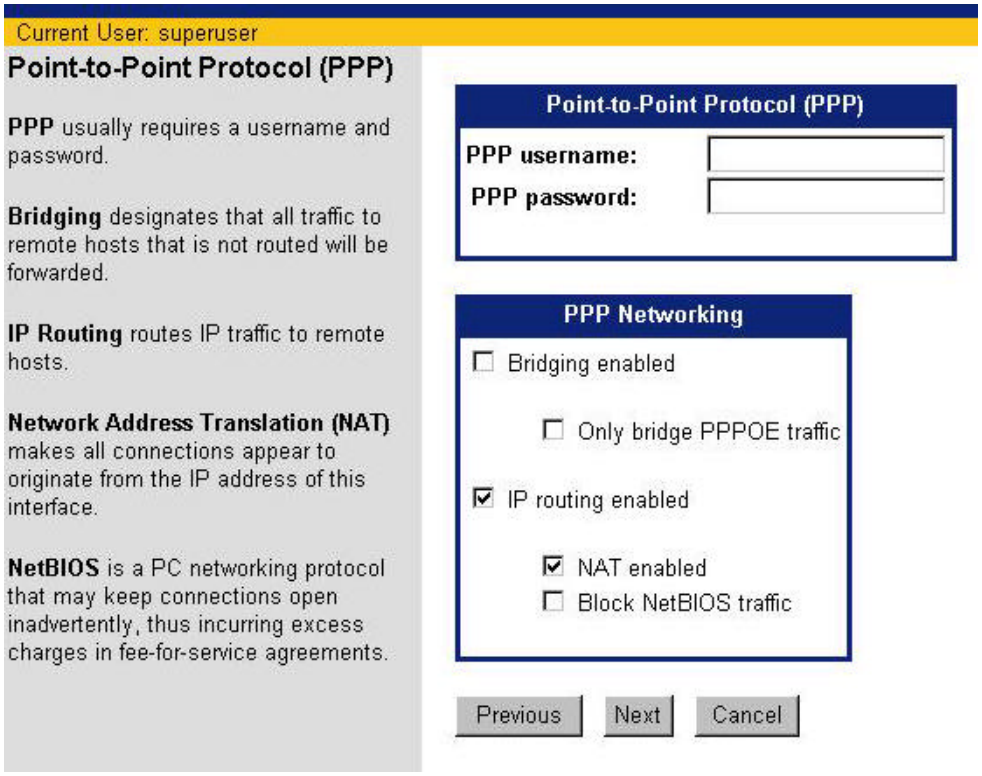
Task Complete

Based on the selection in Step 2, proceed to the appropriate page:

- ‘Point-to-Point Protocol over ATM” on page 8-6
- ‘Point-to-Point Protocol over Ethernet over PPPoA” on page 8-7
- ‘Point-to-Point over Ethernet over RFC 1483” on page 8-8
- ‘RFC 1483 Networking” on page 8-10
- ‘RFC 1483 MAC Encapsulated Routing” on page 8-12

Point-to-Point Protocol over ATM

Selection of Point-to-Point Protocol over ATM will display the following *PPP Configuration* page.



To continue the Easy Setup procedure with PPP over ATM, continue with the following steps:

Step 1 Enter the PPP ***User Name*** and ***Password*** in the fields provided.

A PPP Username and password are required for authentication when the connection is being established.

Step 2 Click to select the following *PPP Networking* options:

- ***Bridging Enabled*** - Bridging will forward all traffic for remote hosts that is not routed (non-IP) to the WAN. If Bridging Enabled is selected:
  - Optional, click to select *Only bridge PPPoE traffic*. Proceed to Step 4.

  Selection of this option will allow only PPPoE traffic to be bridged, all other traffic will be dropped.
- ***IP Routing Enabled*** - IP Routing will route all IP packets for remote hosts to the WAN.

If IP Routing enabled is selected, click to select the following options:

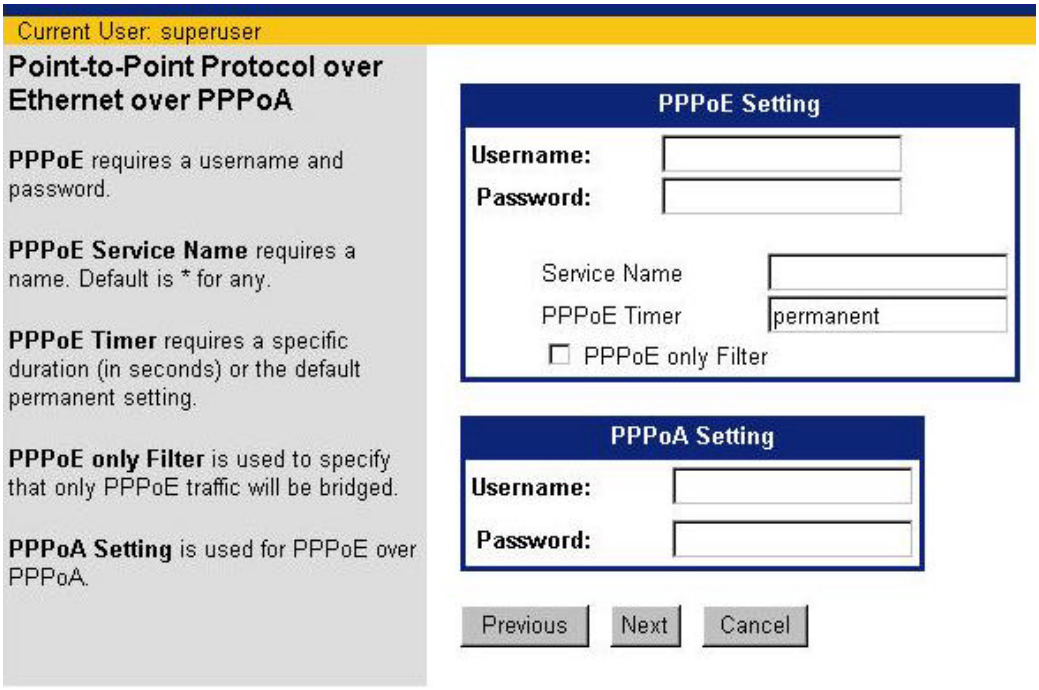
- ***NAT Enabled*** - Network Address Translation (NAT) allows multiple workstations on your LAN to share a single, public IP address. All outgoing traffic appears to originate from the router's IP address.
- ***Block Net BIOS Traffic*** - NetBIOS is a PC networking protocol that can keep network connections open inadvertently. To avoid excess connection charges, such traffic should be blocked on any metered network service.

Step 3 Click **Next** to proceed with Easy Setup, Dynamic Host Configuration Protocol configuration (see page 8-14).

Task Complete

Point-to-Point Protocol over Ethernet over PPPoA

Selection of Point-to-Point Protocol over Ethernet over PPPoA will display the following *PPPoE Configuration* page.



To continue the Easy Setup procedure with PPPoE, continue with the following steps:

Step 1 Enter the PPP ***User Name*** and ***Password*** in the field provided.

A PPP Username and password are required for authentication when the connection is being established.

Step 2 Enter the PPPoE ***Service Name*** in the field provided.

PPPoE requires the domain name of your network service provider. Use * as a default (for all services). Enter the domain name of your network service provider in the Service Name field.

Step 3 Enter the ***timeout interval*** (measured in seconds) into the *PPPoE Timer* field.

PPPoE Timer will set a timeout interval for periods of inactivity. After the number of seconds elapses, the PPP connection closes to limit timed connection charges from your service provider. The default entry of “permanent” will keep the PPP connection open constantly, with no timeout interval.

Step 4 As required, click to select ***PPPoE only Filter***.

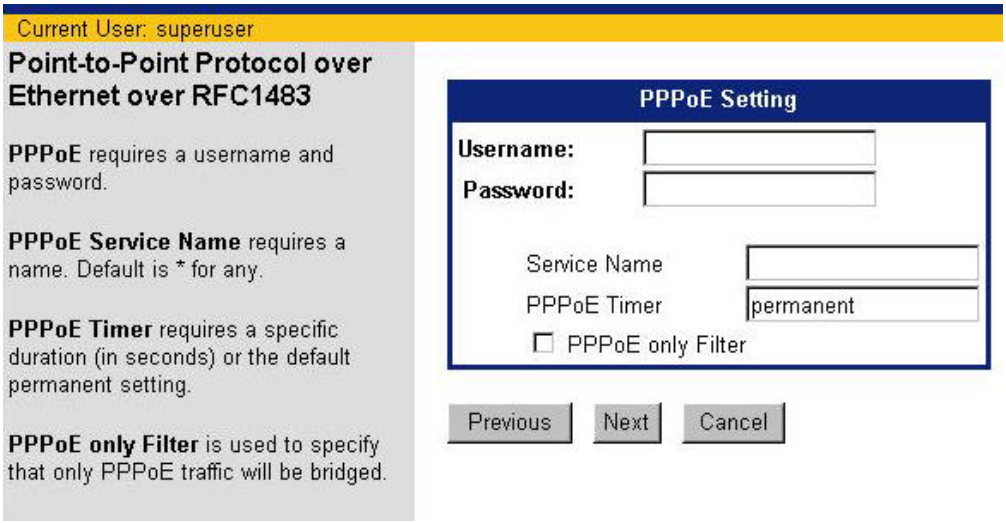
This selection will filter all traffic on the bridge to allow PPPoE only. Check this box if you will only connect to your network service using PPPoE.

Step 5 Click **Next** to proceed with Easy Setup, Dynamic Host Configuration Protocol configuration (see page 8-14).

Task Complete

Point-to-Point over Ethernet over RFC 1483

Selection of Point-to-Point Protocol over Ethernet over RFC 1483 will display the following *PPPoE Configuration* page.



To continue the Easy Setup procedure with PPPoE, continue with the following steps:

Step 1 Enter the PPP ***User Name*** and ***Password*** in the fields provided.

A PPP Username and password are required for authentication when the connection is being established.

Step 2 Enter the PPPoE ***Service Name*** in the field provided.

PPPoE requires the domain name of your network service provider. Use * as a default (for all services). Enter the domain name of your network service provider in the Service Name field.

Step 3 Enter the ***timeout interval*** (measured in seconds) into the *PPPoE Timer* field.

PPPoE Timer will set a timeout interval for periods of inactivity. After the number of seconds elapses, the PPP connection closes to limit timed connection charges from your service provider. The default entry of “permanent” will keep the PPP connection open constantly, with no timeout interval.

Step 4 As required, click to select ***PPPoE only Filter***.

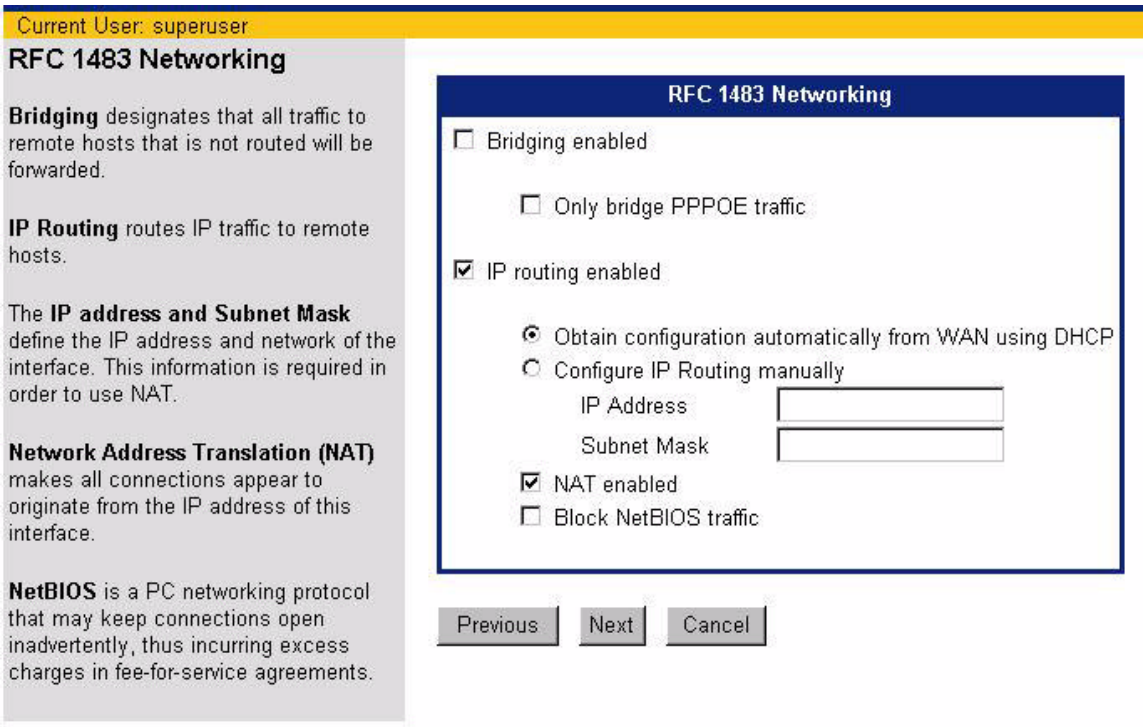
This selection will filter all traffic on the bridge to allow PPPoE only. Check this box if you will only connect to your network service using PPPoE.

Step 5 Click **Next** to proceed with Easy Setup, Dynamic Host Configuration Protocol configuration (see page 8-14).

Task Complete

RFC 1483 Networking

Selection of RFC 1483 will display the following *RFC 1483 Networking* configuration page.



To continue the Easy Setup procedure with RFC 1483, continue with the following steps:

Step 1 Click to select *one* of the following.

- ***Bridging enabled***
- ***IP routing enabled***

If bridging is selected, all traffic to remote computers that is not routed will be bridged. Next, continue to Step 2.

If IP routing was selected, an IP address and subnet mask must be obtained; proceed to Step 3.

☞ **NOTE:**

If your Network Service Provider has not provided specifics for use in making these settings, select the following *IP Routing*, *Obtain configuration automatically from WAN*, and *NAT enabled*.

Step 2 Optional, click to select *Only bridge PPPoE traffic*. Proceed to Step 4.

Selection of this option will allow only PPPoE traffic to be bridged, all other traffic will be dropped.

Step 3 Obtain an IP address, select from the two bulleted options below:

- *IP configuration automatically from a DHCP server on the WAN Using DHCP*.

(1) Click the radio button to select this option.

- *Configure IP Routing manually*. This procedure requires the following:

(1) Click the radio button to select this option.

(2) Enter a unique ***IP Address*** in the field provided.

(3) Enter a unique ***Subnet Mask*** in the field provided.

If IP Routing enabled is selected, click to select the following options:

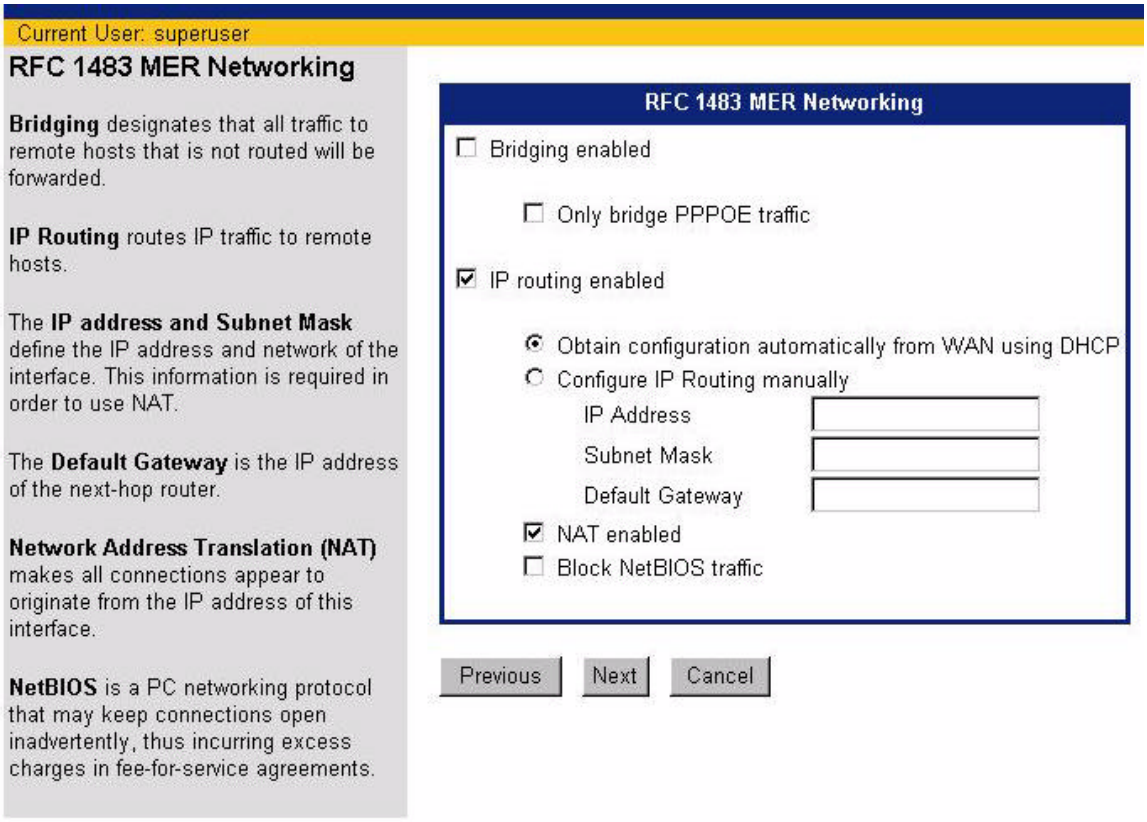
- ***NAT Enabled*** - Network Address Translation (NAT) allows multiple workstations on your LAN to share a single, public IP address. All outgoing traffic appears to originate from the router's IP address.
- ***Block Net BIOS Traffic*** - NetBIOS is a PC networking protocol that can keep network connections open inadvertently. To avoid excess connection charges, such traffic should be blocked on any metered network service.

Step 4 Click **Next** to proceed with Easy Setup, Dynamic Host Configuration Protocol configuration (see page 8-14).

Task Complete

RFC 1483 MAC Encapsulated Routing

Selection of RFC 1483 MAC Encapsulated Routing (MER) will display the following *RFC 1483 MER Networking* configuration page.



To continue the Easy Setup procedure with RFC 1483 MER, continue with the following steps:

Step 1 Click to select one of the following.

- ***Bridging enabled***
- ***IP routing enabled***

If bridging is selected, all traffic to remote computers that is not routed will be bridged. Next, continue to Step 2.

If IP routing was selected, an IP address and subnet mask must be obtained; proceed to Step 3.

☞ **NOTE:**

If your Network Service Provider has not provided specifics for use in making these settings, select the following *IP Routing*, *Obtain configuration automatically from WAN*, and *NAT enabled*.

Step 2 Optional, click to select *Only bridge PPPoE traffic*. Proceed to Step 4.

Selection of this option will allow only PPPoE traffic to be bridged, all other traffic will be dropped.

Step 3 Obtain an IP address, select from the bulleted options below:

- *Obtain configuration automatically from WAN using DHCP*

(1) Click the **radio button** to select this option.

- *Configure IP routing manually*. This procedure requires the following:

(1) Click the **radio button** to select this option.

(2) Enter a unique ***IP Address*** in the field provided.

(3) Enter a unique ***Subnet Mask*** in the field provided.

If IP Routing enabled is selected, click to select the following options:

- ***NAT Enabled*** - Network Address Translation (NAT) allows multiple workstations on your LAN to share a single, public IP address. All outgoing traffic appears to originate from the router's IP address.
- ***Block Net BIOS Traffic*** - NetBIOS is a PC networking protocol that can keep network connections open inadvertently. To avoid excess connection charges, such traffic should be blocked on any metered network service.

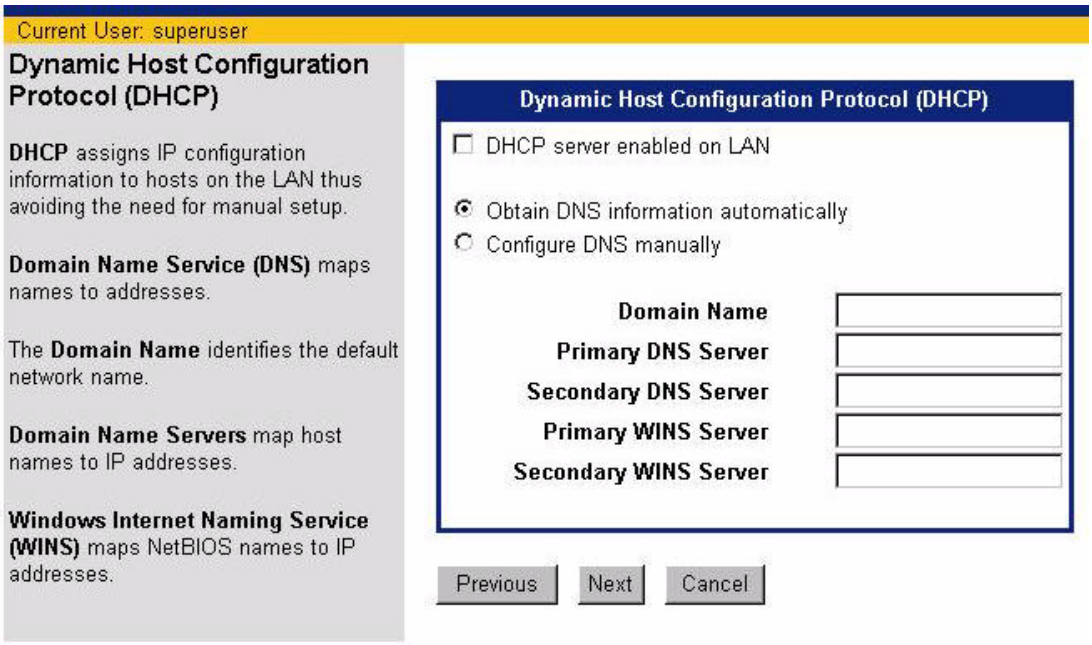
Step 4 Click **Next** to proceed with Easy Setup, Dynamic Host Configuration Protocol configuration (see page 8-14).

Task Complete

Dynamic Host Configuration Protocol

The next step in Easy Setup is configuration of DHCP. DHCP dynamically assigns IP configuration information to PCs on the LAN, thus avoiding the need to set IP configurations for each PC manually. For more information on DHCP, see "DHCP (Dynamic Host Configuration Protocol)" on page 4-2.

This configuration form also provides for configuration of DNS (Domain Name Service). DNS maps host names to IP addresses. The Easy Setup *DHCP* Configuration page is shown below.



To continue the Easy Setup procedure by configuring DHCP, continue with the following steps:

Step 1 Optional, click to select ***DHCP server enabled on the LAN***.

Selecting this option will allow the DHCP server to dynamically assign IP address information to all LAN-side machines.

Step 2 Configure Domain Name Service. Select one of the bulleted options

- *Obtain DNS information automatically*

Selecting this option will enable the DNS on the router. The DNS server address will be learned when DHCP client requests are placed over the WAN link.

- *Configure DNS manually*

Selection of manual DNS configuration requires a minimum of one *DNS Server Address* and a *Domain Name*. This information should be provided by the Service Provided. Enter the DNS information as described below:

a. Enter the ***Domain Name*** in the field provided.

   This sets the router's DNS domain name

b. Enter the ***IP address*** of the *Primary DNS Server* in the field provided.

   This establishes where DNS requests will be sent.

c. Optional, enter the ***IP address*** of the *Secondary DNS Server* in the field provided.

   This establishes where DNS requests will be sent if the primary DNS server is unavailable.

d. Enter the ***IP address*** of the *Primary WINS Server* in the field provided.

   The Windows Internet Naming Service (WINS) maps NetBIOS names to IP addresses similar to DNS. This establishes where WINS requests will be sent.

e. Optional, enter the ***IP address*** of the *Secondary WINS Server* in the field provided.

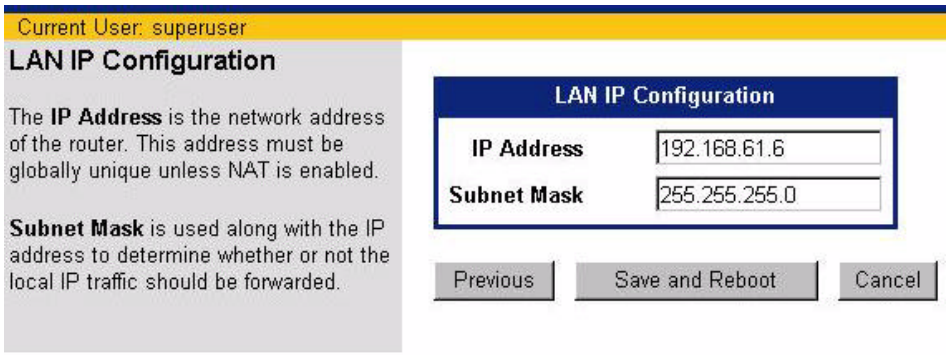
   This establishes where WINS requests will be sent if the primary server is unavailable.

Step 3 Click **Next** to continue Easy Setup.

Task Complete

Local Area Network Configuration

The final screen in Easy Setup is for Local Area Network (LAN) configuration.



To continue the Easy Setup procedure by configuring the LAN IP address, continue with the following steps:

Step 1 Enter the ***IP Address*** in the field provided.

The IP address is the network address of your router. This address must be globally unique, unless NAT has been enabled.

Step 2 Enter the ***Subnet Mask*** in the field provided.

The subnet mask is used along with the IP address to determine if specific LAN IP traffic should be forwarded to the WAN.

Step 3 Click **Save and Reboot**.

Changes made within the Easy Setup procedure will be saved and made persistent across system reboot functions. The router will reboot with the new configuration settings.

Step 4 On completion of the reboot process, you will be required to login. If after 3 minutes, the Router Information Page is not displayed, click the link in the restart message to establish the WMI connection at the new IP address. The message is shown below.

Your router will restart at http://192.168.61.19/. If your browser can not reload automatically in 3 minutes, please click the link. Thanks for waiting...

Task Complete

User Management

The User Management forms allow the management of user accounts.

User Management Navigation
From the Main Menu, select: > User Management > User Lookup Configuration > Secure Mode Configuration

User Management Main Page

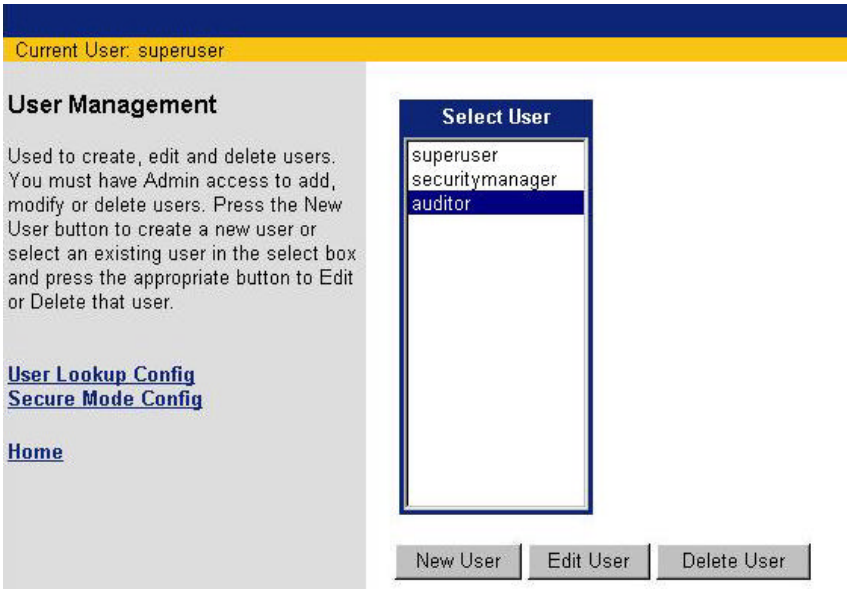
The *User Management Main* page displays a listing of the current user accounts as well as providing the ability to manage user accounts. Management of user accounts includes:

- Adding A User Account
- Deleting A User Account
- Editing A User Account

This page also serves as the access point for the following functions:

- User Lookup Configuration
- Secure Mode Configuration

The *User Management* Main page is shown below:

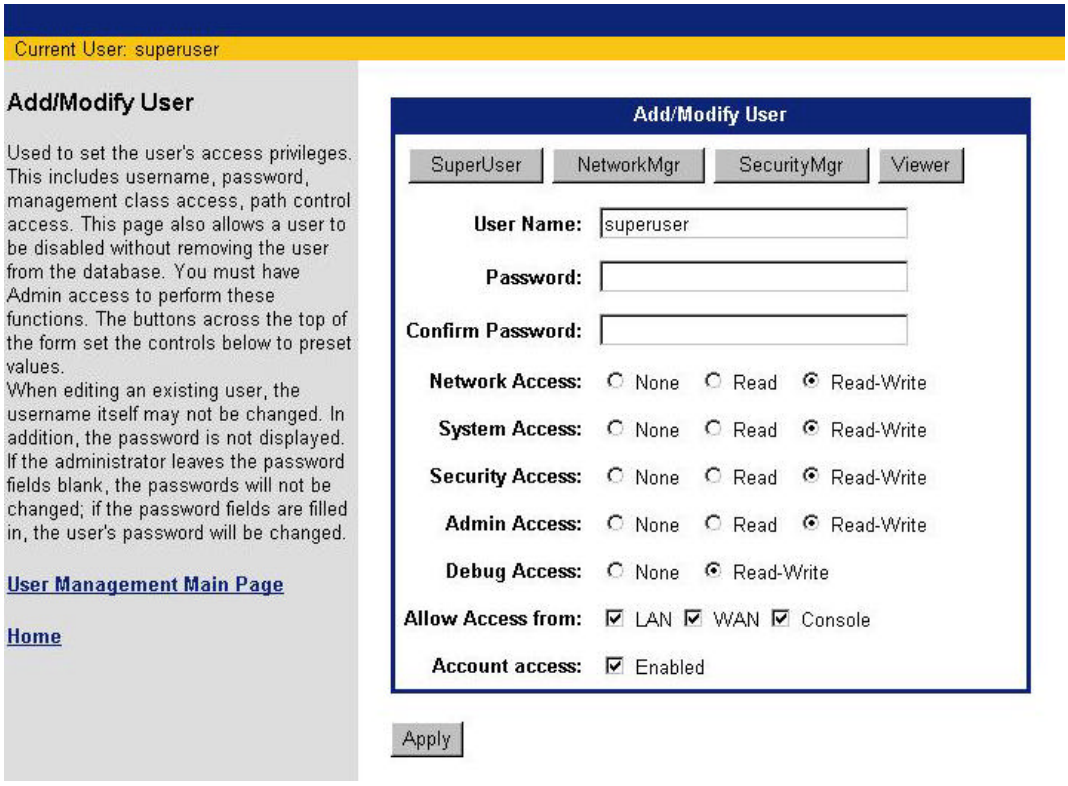


Adding A User Account

To add a user account, perform the following procedure. For additional information on user account configuration, see "User Authentication" on page 5-2.

Step 1 From the *User Management* Main page, click **New User**.

The *Add/Modify User* page is displayed.



Step 2 Enter the ***User Name*** in the field provided.

Step 3 Enter the user password information

a. Enter the ***Password*** in the field provided.

b. Re-enter to ***Confirm Password*** in the field provided.

Step 4 Specify the user account management class privileges:

Privileges can be configured in a number of ways.

- From the buttons across the top of the configuration form, click to select a *User Template*.

To facilitate configuration, pre-configured templates have been built that contain pre-set privileges based on common user roles. Once a template has been selected, user privileges can still be modified manually.

- For each management activity class, click to select the **Read** / **Read-Write** privileges for the user, or select **None** for no privilege.

Step 5 Click to select where the user account will be *Allow(ed) Access from*: **LAN**, **WAN**, and/or **Console**.

Step 6 The user account is enabled by default. As required, click to de-select **Enable** to disable the *Account access*.

Step 7 Click **Apply** to add the user account.

Task Complete

Deleting A User Account

To delete a user account, perform the following:

Step 1 On the *User Management Main page,* click to select the **User Account** from the *Select User* menu.

Step 2 Click **Delete User**.

Task Complete

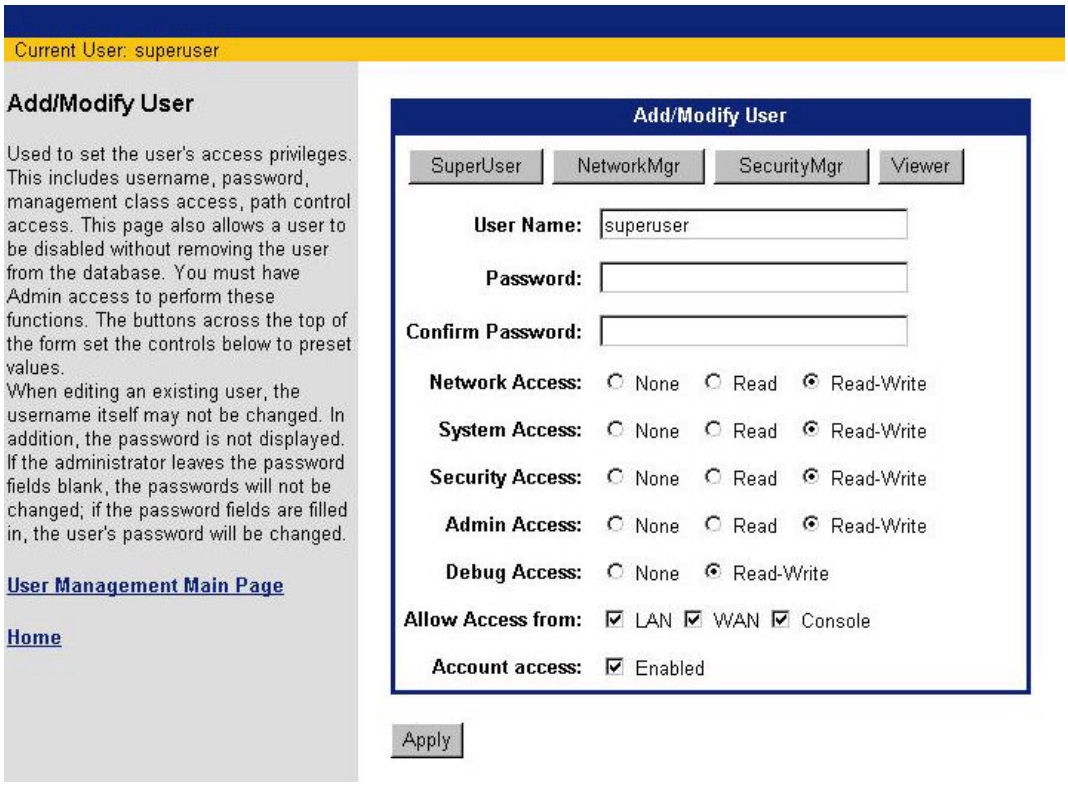
Editing A User Account

To add a edit an existing account, perform the following procedure. For additional information on user account configuration, see “User Authentication” on page 5-2.

Step 1 On the *User Management Main page,* click to select the **User Account** from the *Select User* menu.

Step 2 From the *User Management* Main page, click **Edit User**.

The *Add/Modify User* page is displayed.



As required, edit the current user account information as required.

CAUTION:

Changing the password or privileges of an existing user account may terminate a user's current activity.

NOTE:

The User Name cannot be modified for an existing account.

Step 3 Edit the user password information

a. Enter the new ***Password*** in the field provided.

b. Re-enter to ***Confirm Password*** in the field provided.

Step 4 Specify the user account management class privileges:

Privileges can be configured in a number of ways.

- From the buttons across the top of the configuration form, click to select a *User Template*.

To facilitate configuration, pre-configured templates have been built that contain pre-set privileges based on common user roles. Once a template has been selected, user privileges can still be modified manually.

- For each management activity class, click to select the **Read** / **Read-Write** privileges for the user, or select **None** for no privilege.

Step 5 Click to select where the user account will be *Allow(ed) Access from*: **LAN**, **WAN**, and/or **Console**.

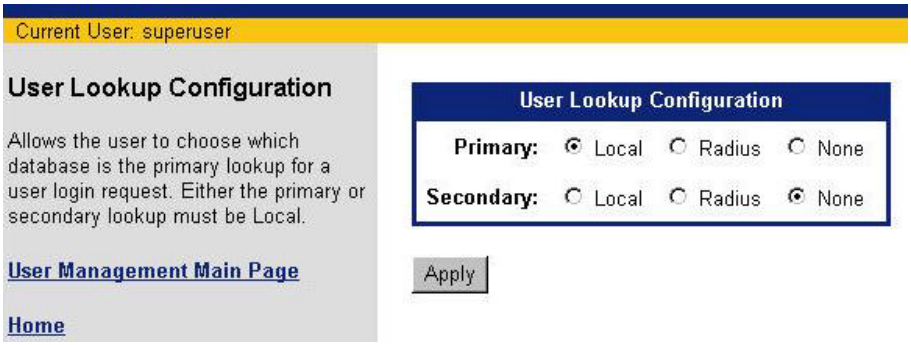
Step 6 The user account stauts is shown. As required, click to select/de-select **Enable** to speficy the *Account access*.

Step 7 Click **Apply** to add the user account.

Task Complete

User Lookup Configuration

The *User Lookup Configuration* page allows the administrator to define the search order (primary and secondary) for user login requests. The *User Look Configuration* page is shown below.



The selection options are as follows:

- **Local** - Local will query the local user database, held in flash memory.
- **Radius** - will cause the RADUIS client to generate an encrypted Access Request to a configured RADIUS server. RADIUS is a key-enabled feature.
- **None** - indicates only the specified alternative method will be used.

☞ NOTE:

At least one lookup selection (primary or secondary) will always be Local. Setting either the primary or secondary for *Radius* or *None*, will default the alternate lookup to *Local*.

For additional topic information, see "User Lookup" on page 5-6. To configure User Lookup, perform the following:

Step 1 Click to select the ***Primary*** lookup location.

Step 2 Click to select the ***Secondary*** lookup location.

Step 3 Click **Apply** to save the changes.

Task Complete

Secure Mode Configuration

Secure Mode is a feature that can restrict system access to the use of only secure channels. Secure mode can be employed for the WAN interface, LAN interface or both. When secure mode is enabled, an interface can be designated as trusted, indicating that unsecure connections are allowed via the specified interface. Designating an interface as untrusted will enforce the requirement of a secure channel for access via the specified interface. By default, the WAN interface is untrusted and the LAN interface is trusted.

The *Secure Mode Configuration* page is shown below.

☞ **NOTE:**

When secure mode is enabled, all current non-secure connections via an untrusted interface will be terminated immediately with the exception of inbound file transfers. Inbound file transfers will allowed to complete prior to session termination.

To configure Secure Mode, perform the following:

Step 1 As required, click the check box to ***Enable*** or ***Disable*** (box unchecked) *Secure Mode*.

Step 2 Click to select the ***LAN Interface*** mode.

Step 3 Click to select the ***WAN Interface*** mode.

Step 4 Click **Apply** to save the changes.

Task Complete

Change Password

The *Change Password* form allows the current user to change their password.

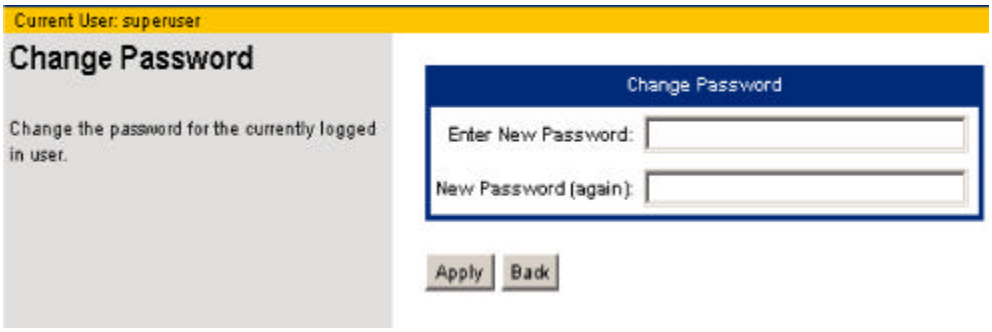
Change Password Navigation
From the Main Menu, select: > Change password

To change a password, perform the following:

Step 1 Enter the ***new password*** in the field provided.

Step 2 Re-enter the ***new password*** in the field provided.

Step 3 Click **Apply** to save the password change.



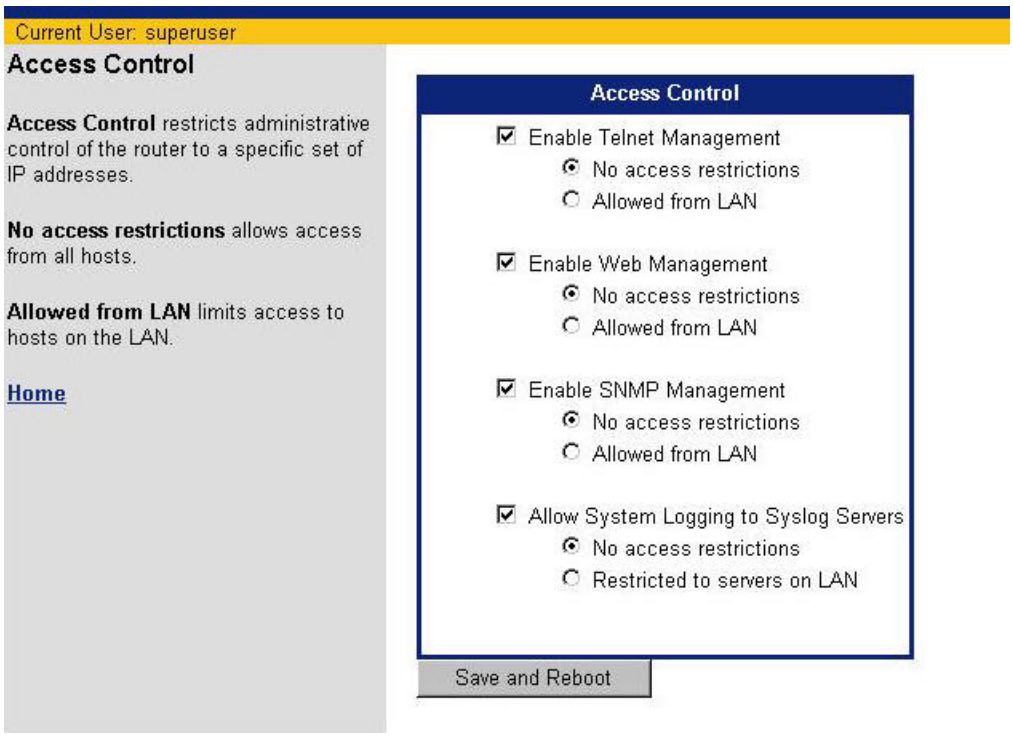
Task Complete

Access Control Form

The Access Control form is used to configure access restrictions for user's attempting administrative control of the system; serial console access is restricted here since physical limitations can restrict access. Each remote access method can be set to one of three levels of accessibility as shown in the Access Control page below:

- Enabled, no restrictions. Check box is selected, and No access restrictions is selected.
- Enabled, access allowed only from LAN. Check box is selected, Allowed from LAN is selected.
- Disabled, no access. Check box is not selected, the radio button selection is not regarded.

Configuration examples of each level are illustrated on the following page.



Examples

The following examples illustrate the three levels of restricting access. The examples apply to Telnet, Web, SNMP and Syslog Server management access.

- This example places no restrictions on the selected management method.

- This example would limit Telnet access to LAN-side hosts only.

- This example would limit Telnet access to LAN-side hosts only.

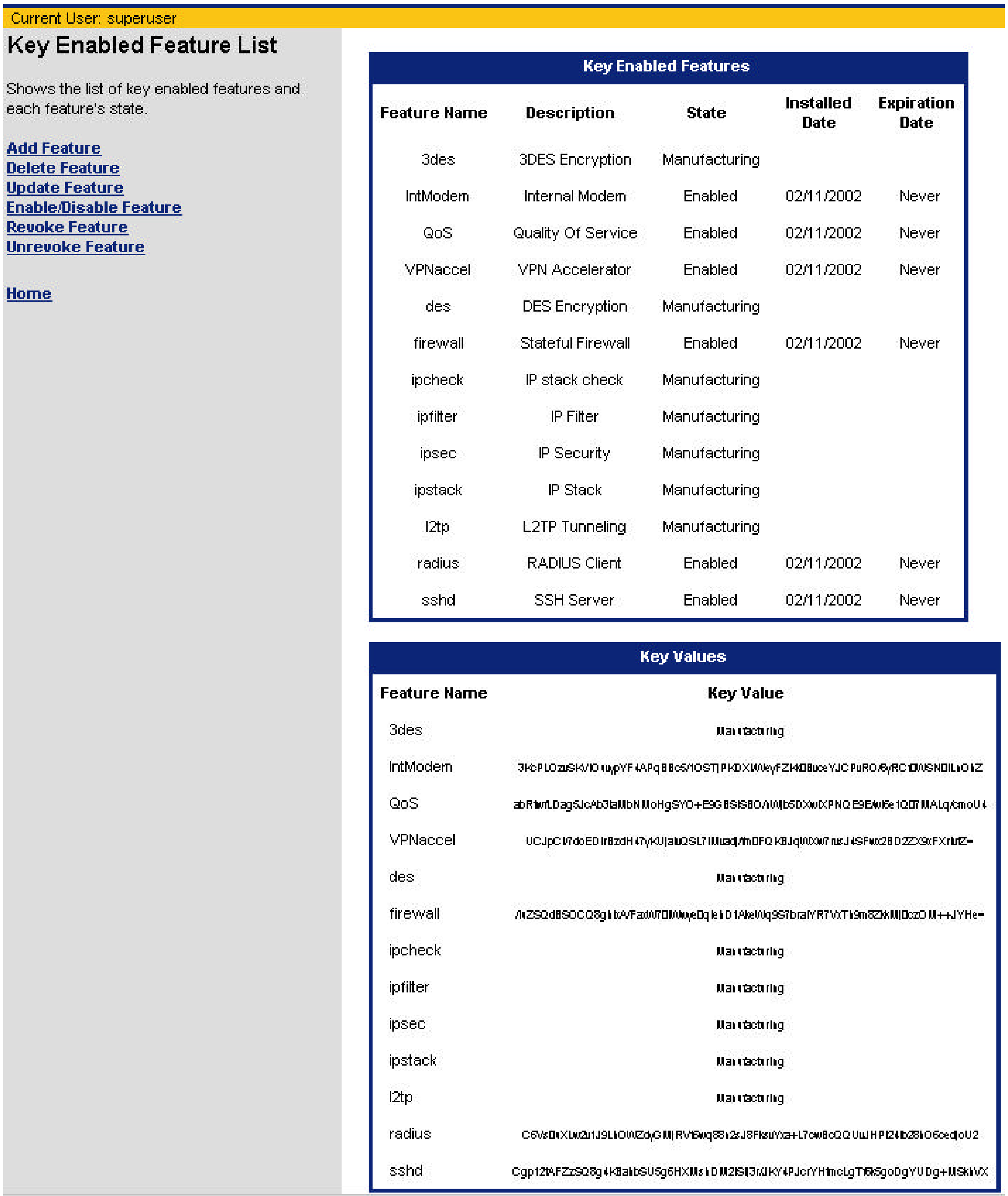
Feature Activation

The router has several optional software key-enabled features that can be purchased as software option keys (feature activation keys) when ordering the router. The Feature Activation page and subsequent feature key pages are used for key management. For more detailed information on feature keys, see “Key Enabled Features” on page 4-29.

Key Enabled Features Navigation
From the Main Menu, select: > Feature Activation > Key Enabled Feature List > Add Feature > Delete Feature > Update Feature > Enable/Disable Feature > Revoke Feature > Unrevoke Feature

Key Enabled Feature List Page

The *Key Enabled Feature List* page provides a listing of the key-enabled features available on your router, the feature's key status as well as the key-string. A typical *Key Enabled Feature List* page is shown below.



Current User: superuser

Key Enabled Feature List

Shows the list of key enabled features and each feature's state.

Add Feature
Delete Feature
Update Feature
Enable/Disable Feature
Revoke Feature
Unrevoke Feature

Home

Key Enabled Features

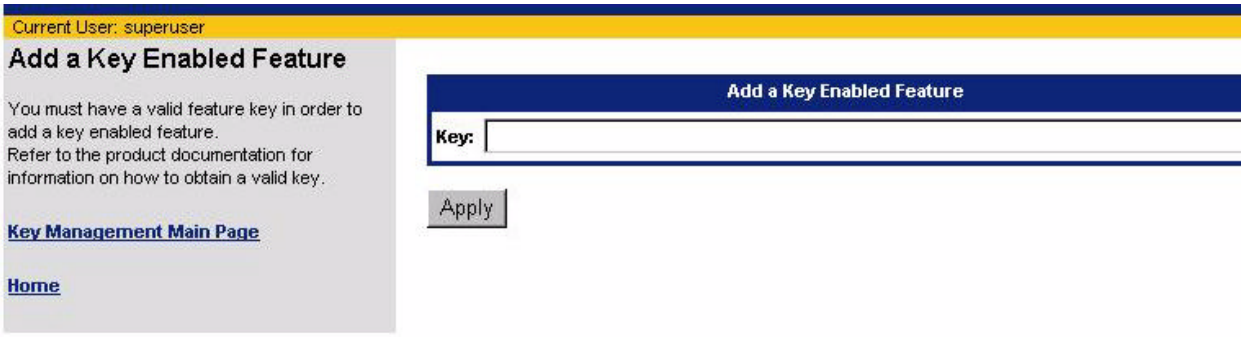
Feature Name	Description	State	Installed Date	Expiration Date
3des	3DES Encryption	Manufacturing		
IntModem	Internal Modem	Enabled	02/11/2002	Never
QoS	Quality Of Service	Enabled	02/11/2002	Never
VPNaccel	VPN Accelerator	Enabled	02/11/2002	Never
des	DES Encryption	Manufacturing		
firewall	Stateful Firewall	Enabled	02/11/2002	Never
ipcheck	IP stack check	Manufacturing		
ipfilter	IP Filter	Manufacturing		
ipsec	IP Security	Manufacturing		
ipstack	IP Stack	Manufacturing		
l2tp	L2TP Tunneling	Manufacturing		
radius	RADIUS Client	Enabled	02/11/2002	Never
sshd	SSH Server	Enabled	02/11/2002	Never

Key Values

Feature Name	Key Value
3des	Manufacturing
IntModem	[illegible]
QoS	[illegible]
VPNaccel	[illegible]
des	Manufacturing
firewall	[illegible]
ipcheck	Manufacturing
ipfilter	Manufacturing
ipsec	Manufacturing
ipstack	Manufacturing
l2tp	Manufacturing
radius	[illegible]
sshd	[illegible]

Add Feature Page

The *Add Feature* page is the form used to add the key strings enabling system features. A feature activation key is a 76-character string, unique to a particular router by serial number. The *Key Add* page is shown below.



To add a feature key, perform the following:

Step 1 Copy and paste, or manually enter the ***Key*** string in the space provided.

Step 2 Click **Apply** to enter the string

Step 3 Verify the feature key installation:

a. Click the *Key Management Main Page* link.

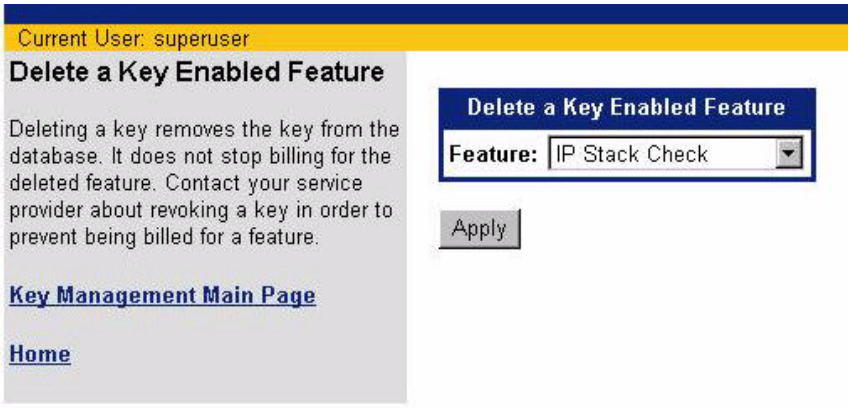
b. Verify the feature installation is properly displayed (*Enabled*) in the Key Enabled Features listing.

Task Complete

Delete Feature Page

The *Delete Feature* page is used to delete an active key from the system. When a key is deleted, all feature configuration information is cleared and access is removed. Features with a key state of *Manufacturing* or *Legacy* cannot be deleted.

If desired, the feature can be added again re-using the original activation key; this will not change the expiration date. You may also acquire a new activation key. The feature can also be disabled without deleting the key. For more information on disabling a key, see "Enabling and Disabling Features" on page 4-33. The *Delete Feature* page is shown below.



To delete a feature key, perform the following:

Step 1 From the pull-down menu, select the ***Feature*** to be deleted.

Step 2 Click **Apply**.

Step 3 Verify the feature key is not longer installed:

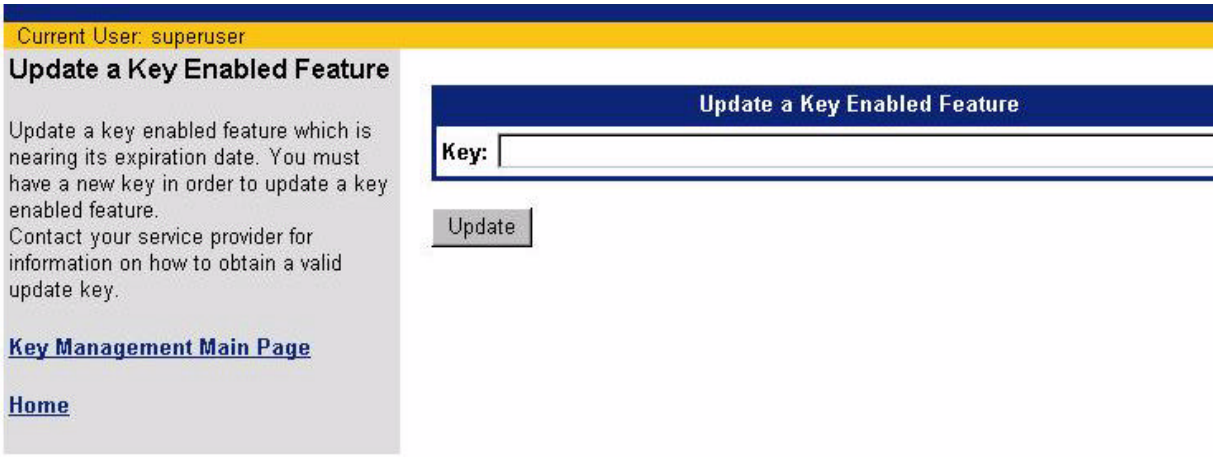
a. Click the *Key Management Main Page* link.

b. Verify the *Key Enabled Features List* indicates the feature key is *Not Installed* for the prescribed feature.

Task Complete

Update Feature Page

Some feature keys are generated with a expiration date. If continued use of the feature is desired, an update key will be necessary to extent the key expiration date. The *Update Feature* page is used to replace an existing Activation key with a new Activation key. The *Feature Update* page is shown below.



To update a feature key, perform the following:

Step 1 Copy and paste, or manually enter the ***Key*** string in the space provided.

Step 2 Click **Apply** to enter the string

Step 3 Verify the feature Expiration Date:

a. Click the *Key Management Main Page* link.

b. Verify the feature *Expiration Date* is correct in the *Key Enabled Features List*.

Task Complete

Feature Enabled/Disable Page

When a feature has been key-enabled, it may be disabled pending additional configuration or as operational requirements may bear. The *Key Enable / Disable* page is used to change the state of an enabled or disabled feature; this page is shown below.

When a feature is disabled it is in an inactive state; no changes are made to the feature configuration and the feature expiration date, if any, does not change. To change a feature key state, perform the following:

Step 1 From the pull-down menu, select the ***Feature*** desired.

Step 2 Click to select the radio button for the preferred state (***enable*** or ***disable***).

Step 3 Click **Apply**.

Step 4 Verify the feature state:

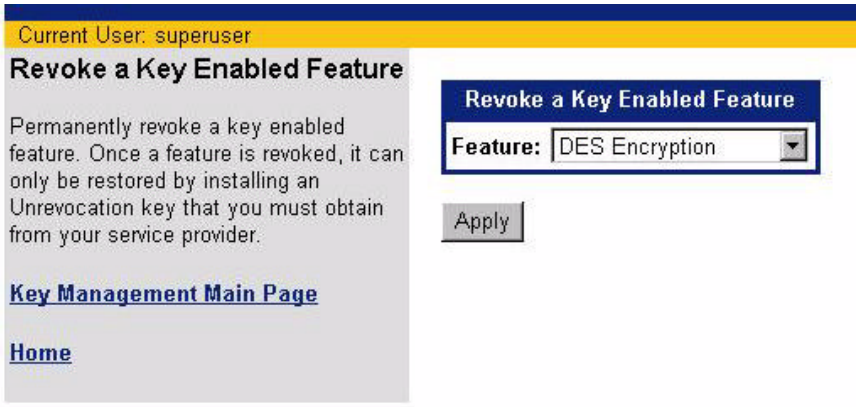
a. Click the *Key Management Main Page* link.

b. Verify the prescribed feature *State* is correct in the *Key Enabled Features List*.

Task Complete

Revoke Feature Page

If a feature is no longer necessary or desired, or if you have been directed to render the feature non-functional through the *Revoke Feature* page (shown below).



To revoke a feature key, perform the following:

Step 1 From the pull-down menu, select the ***Feature*** to revoke.

Step 2 Click **Apply**.

Step 3 Verify the feature key is has been revoked:

a. *Click the Key Management Main Page* link.

b. Verify the feature state in the *Key Enabled Features List* indicates the prescribed feature key *State* is *Revoked*.

Task Complete

Unrevoke Feature Page

The *Unrevoke Feature* page is used to nullify a revocation key and re-enable the feature activation key. To Unrevoke a revoked feature key, perform the following:

Step 1 Copy and paste, or manually enter the ***Key*** string in the space provided.

Step 2 Click **Apply** to enter the string

Step 3 Verify the feature key is has been unrevoked:

a. Click the *Key Management Main Page* link.

b. Verify the feature state in the *Key Enabled Features List* indicates the prescribed feature key *State* is *Unrevoked*.

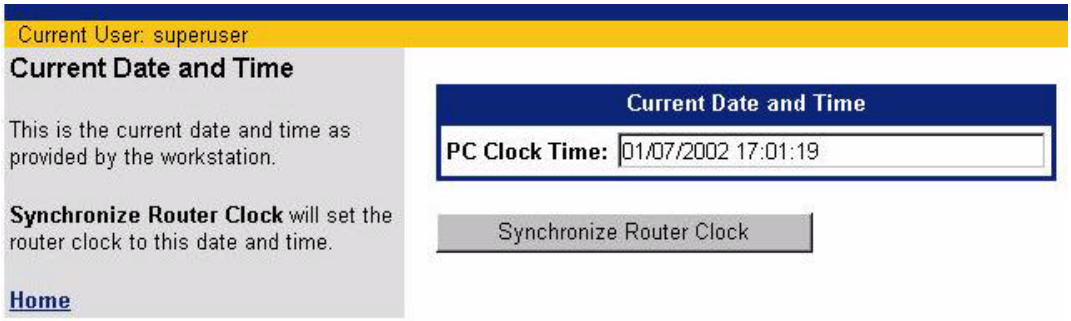
Task Complete

Router Clock Page

This function enables you to set the date and time on your router.

Router Clock Navigation
From the Main Menu, select: > Router Clock

The current date and time from your PC are displayed in the field labeled Current Date and Time. To synchronize the date and time on your router with the current date and time displayed, click on the Synchronize Router Clock button.

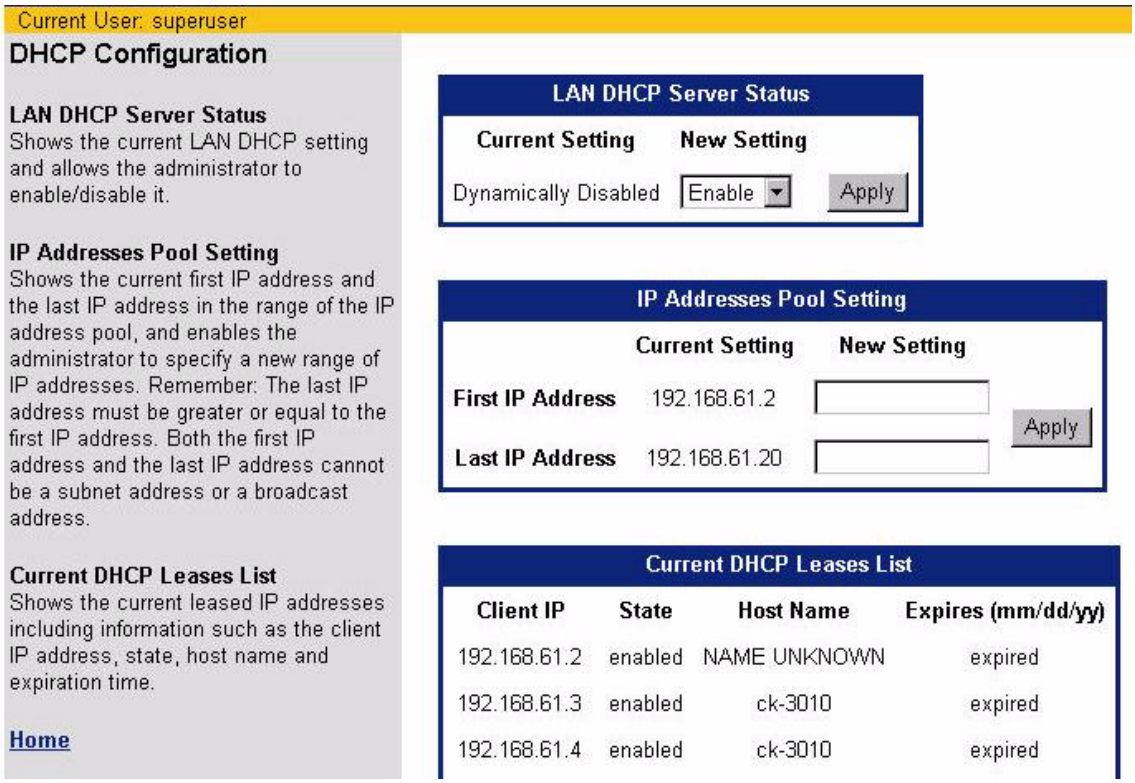


DCHP Configuration

DHCP is a TCP/IP service protocol to provide dynamic leasing of IP addresses and other configuration information to client hosts on the network. The router can perform as a DHCP server with central management of your IP address pool for simple and safe TCP/IP configuration and IP address conservation. For additional information, see “DHCP” on page 4-2.

The *DHCP* page allows viewing and configuration of the current DHCP settings. These settings include:

- LAN DHCP Server Status - Indicates the router’s current DHCP Server mode.
- IP Addresses Pool Setting - Shows the current first IP address and the last IP address in the range of the IP address pool.
- The Current DHCP Leases List shows the network clients that are currently leasing their IP addresses from the pool. From left to right, the following information is presented on each row:
  - Client IP: Displays the leased IP address assigned to that specific client.
  - State: Indicates whether the IP address is enabled or disabled.
  - Host Name: Displays the name of the host leasing that specific IP address.
  - Expires (mm/dd/yy): Displays the date when the IP address lease will expire. At that time (if not before), the leased IP address will be freed for re-assignment, and the network client will need to request a new IP address from the router.



To re-configure the current DHCP values, perform the following step(s):

Step 1 As required, change the current DHCP Server Status:

a. Form the *New Setting* pull-down menu, select the desired the ***LAN DHCP Server Status*** mode.

b. Click **Apply**.

Step 2 As required, enter the *IP Address Pool* information:

a. Enter the ***First IP Address*** in the range of IP address pool in the field provided.

b. Enter the ***Last IP Address*** in the range of IP address pool in the field provided.

c. Click **Apply**.

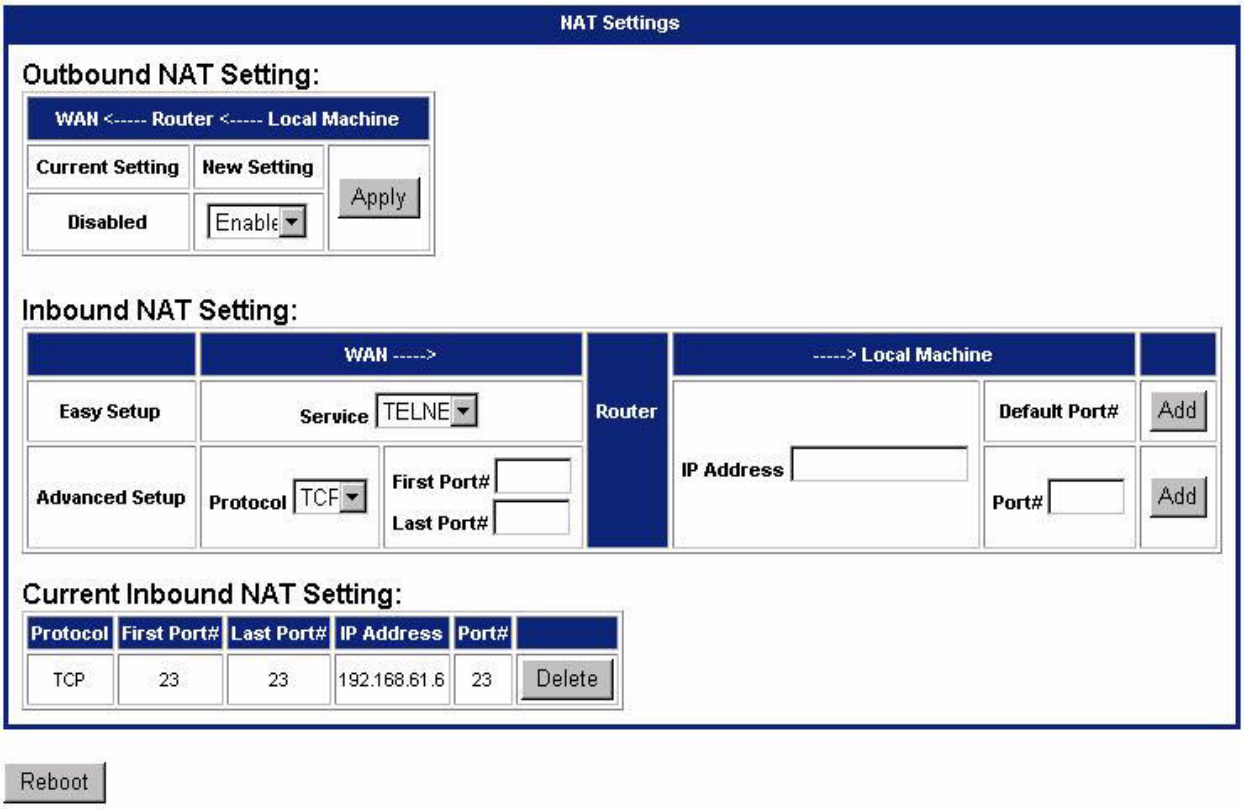
☞ **NOTE:**

The last IP address must be greater or equal to the first IP address. Both the first IP address and the last IP address cannot be a subnet address or a broadcast address.

Task Complete

NAT

Network Address Translation (NAT) is a feature that can provide a level of security by hiding the private IP addresses of your LAN behind the single public IP address of your router. All connections must come through your router and be translated by NAT. Network addresses on inbound traffic are translated from public to private IP addresses, while addresses on outbound traffic are translated from private IP addresses to the router's public IP address, thereby concealing the private IP addresses used on your Local Area Network (LAN). Network Address Translation can provide a level of security by obscurity that is acceptable to many users. The *NAT Settings* form is shown below.



Reboot

Outbound NAT Setting

This field is used to enable or disable Network Address Translation of outbound traffic; communications from your LAN to the Wide Area Network beyond your router (WAN). To set the Outbound NAT mode, perform the following:

Step 1 From the pull-down menu, select the *outbound NAT mode* (***Enable*** or ***Disable***).

Step 2 Click **Apply**.

Task Complete

Inbound NAT Setting

This section of the form is divided into two parts.

- The left side contains fields for WAN settings
- The right side contains fields for local machine settings

A section labeled "router" divides these two parts. This layout is a simple diagram of how NAT works between the WAN and the local machine to translate network addresses.

Two methods are available for making inbound NAT settings:

- Easy Setup
- Advanced Setup

Easy Setup

Easy Setup provides a method for quick configuration inbound NAT to support the most common network services with the Easy Setup fields. To use this method, perform the following:

Step 1 Using the pull-down menu, select a *network service*.

Step 2 Enter the ***IP address*** of the local machine in the field provided.

Step 3 Enter the *Port* Information for the selected service; one of the following options:

a. Click **Add** for *Default Port#* to use the default port for the specified service.

b. Assign an alternate port number for the specified service.

(1) In the *Port#* field, enter the ***alternate port number*** for the selected service.

(2) Click **Add**.

Task Complete

Advanced Setup

The Advanced Setup fields provide the option of assigning specific network protocols to specific ports on the WAN side of NAT, while mapping the WAN settings to an IP address and port number of a local machine. To use the advanced setup, perform the following:

Step 1 From the pull-down menu, select the ***Protocol***.

Step 2 Define the port (range).

a. Enter the ***first port number*** for the protocol in the *First Port#* field.

b. to assign a range of ports for the protocol, enter the ***last port number*** in the range in the *Last Port#* field.

Step 3 Enter the ***IP address*** of the local machine in the IP Address field.

Step 4 Enter the *Local Machine Port* Information for the selected protocol; one of the following options:

a. Click **Add** for ***"Default Port#"*** to use the default port for the specified protocol.

b. Assign an *alternate port number* for the specified protocol.

(1) In the *Port#* field, enter the ***alternate port number*** for the selected protocol.

(2) Click **Add**.

Step 5 Enter the port number on the local machine for the protocol to use. Leave this field blank if you want the local machine to use the same port number as the WAN.

Step 6 Press the Add button next to the Default Port# or the Port# field (as appropriate) to finish your advanced NAT configuration.

Step 7 Repeat Step 1 through Step 6 for each protocol be to configured for NAT.

Step 8 Press Reboot to restart the router with the new NAT settings.

☞ **NOTE:**

Press **Home** to cancel your NAT settings and return to the Router Information Page.

Task Complete

SNMP

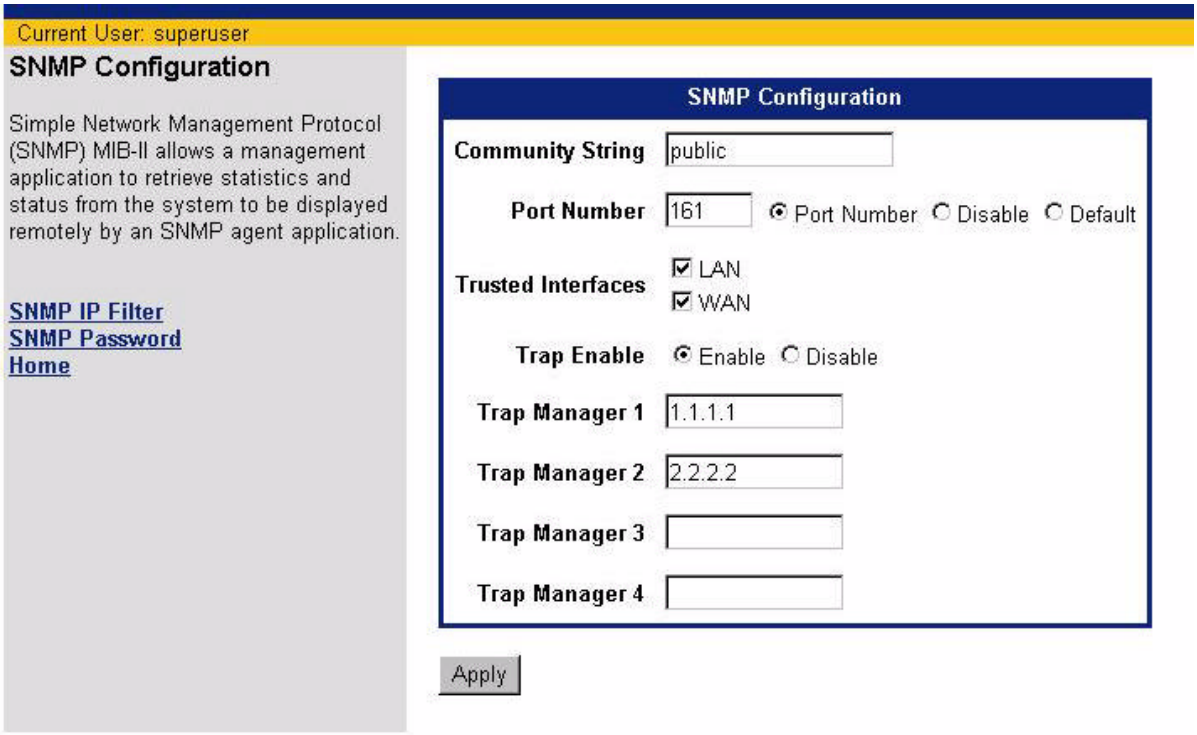
Simple Network Management Protocol (SNMP) is a protocol that provides for the exchange of messages between a management client and a management agent. The message contains requests to get and set variables that exist in network nodes, thus allowing a management client to obtain statistics, set configuration parameters, and monitor events. Communication with the SNMP agent can occur over the LAN or WAN connection. For additional information, see "SNMP" on page 7-2.

SNMP Navigation
From the Main Menu, select: > SNMP Configuration > SNMP IP Filter > SNMP Password

SNMP Configuration Page

The *SNMP Configuration* page allows viewing and configuration of the current SNMP settings. These settings include:

- **Community String** - identifies the SNMP community to which the router belongs. The community acts as a identifier between the SNMP manager and agent for requests. The community setting allows the SNMP manager to request information from a *community*, rather than each node (agent) individually.
- **SNMP Port Number** - allows management of the SNMP port. The SNMP port can be disabled, set to the default (161) or re-defined to a non-standard value.
- **Trusted Interfaces** - defines SNMP participation by interface by enabling or disabling WAN or LAN access.
- **Trap Generation Mode** - Enables and disables trap generation. SNMP agents also have the ability to send (unrequested) messages to SNMP managers; these messages are called traps and notify the SNMP managers that an event has happened on the system.
- **Trap Manager** - The IP address for a node (SNMP manager) that will receive a Trap event from the router.



To configure SNMP, perform the following:

Step 1 Enter the *Community String* In the field provided.

Step 2 Define the SNMP ***Port Number***; click to select one of the following:

- ***Default*** - Returns the SNMP port the default value (161) and re-enables SNMP after it is disabled.
- ***Disable*** - Disables the SNMP port by setting the port to 0.
- ***Port Number***, then in the field provided, enter a number to re-define the SNMP port (range between 1 and 65535).

Step 3 Click to select ***Trusted Interfaces***.

Step 4 Click to select the *Trap generation mode* (***Enable*** or ***Disable***)

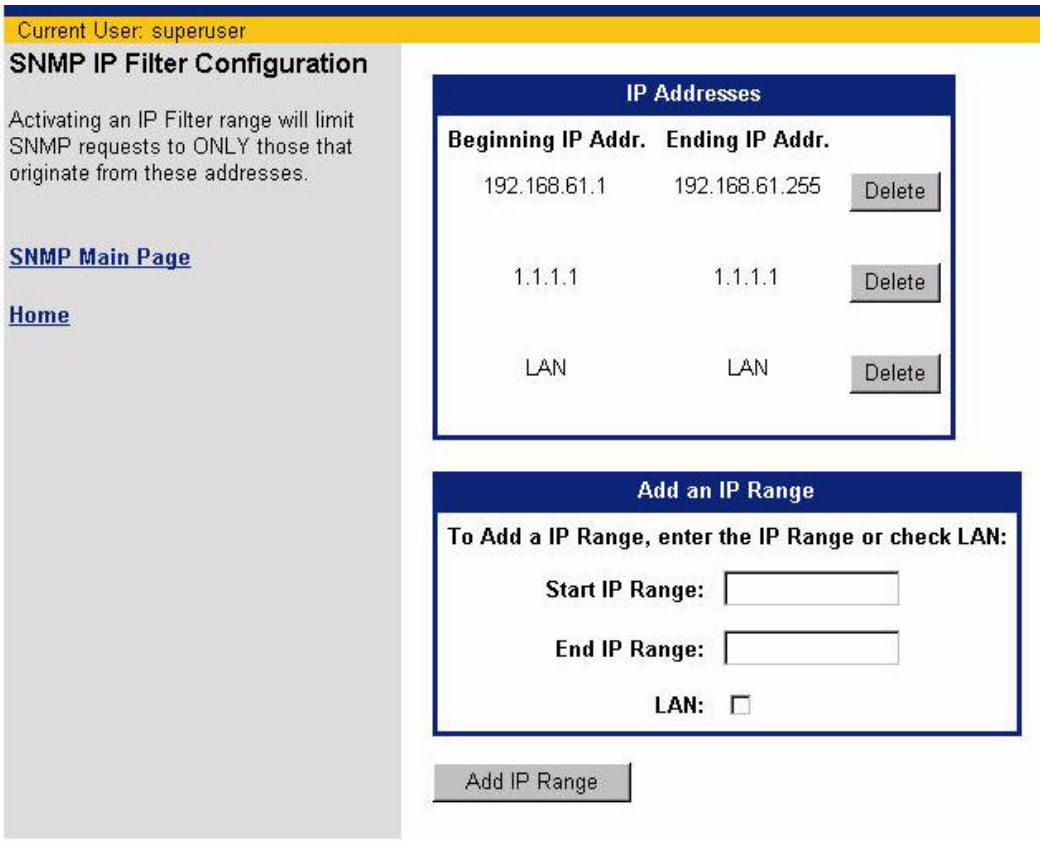
Step 5 In the field provided, enter the ***IP address*** for each *Trap Manager* (1 - 4).

Step 6 Click **Apply** to enable the changes.

Task Complete

SNMP IP Filter Page

The *SNMP IP Filter* page is used to manage SNMP IP filtering. Activating an IP Filter range will limit SNMP requests to only those that originate from the designated addresses or LAN. The current IP filter ranges are displayed in the *IP Address* form.



To add a new filter, perform the following:

Step 1 Enter the filter information:

a. Click to select *LAN*, and / or

b. Enter the ***First IP Address*** in the range of IP addresses, then

c. Enter the ***Last IP Address*** in the range of IP addresses.

Step 2 Click **Add IP Range**.

The page will refresh and the new filer value will be displayed in the *IP Address* form.

Task Complete

To delete a filter, perform the following:

Step 1 Locate the filter to delete in the ***IP Address*** form.

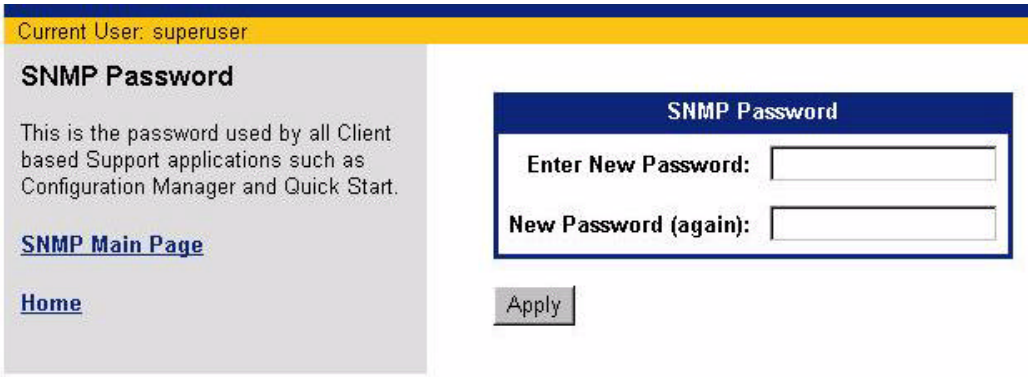
Step 2 Click the corresponding **Delete**.

The page will refresh and the current filters will be displayed in the *IP Address* form.

Task Complete

SNMP Password Page

The *SNMP Password* page is used to change to SNMP password. The password is used to authenticate an SNMP Manager. Once authenticated, SNMP set requests will be honored allowing changes to the system configuration.



To change the SNMP Password, perform the following:

Step 1 Enter the ***New Password*** in the field provided.

Step 2 Enter the ***New Password again*** in the field provided.

Step 3 Click **Apply** to enable the password change.

Task Complete

SSH

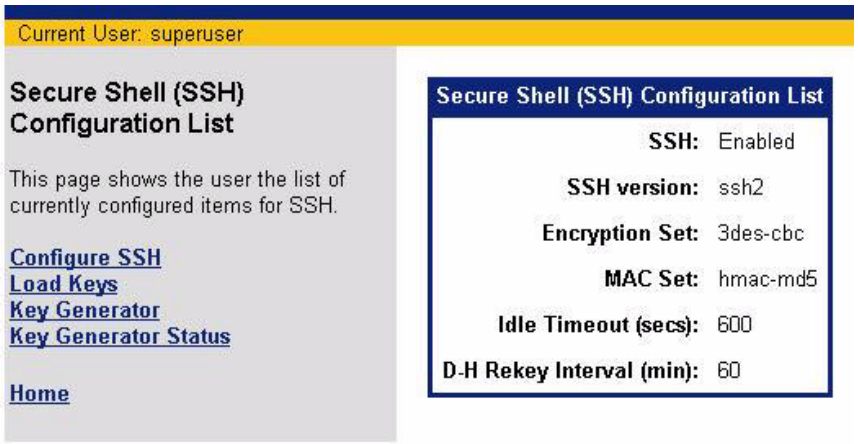
Secure Shell (SSH) allows secure network services over an insecure network such as the public Internet. The objective of SSH is to make a secure functional equivalent for telnet. Telnet connections and command are vulnerable to a variety of different kinds of attacks, allowing unauthorized system access, and even allowing interception and logging of traffic to and from the system including passwords. SSH also provides secure FTP type file transfer. For more information, see "SSH" on page 5-70.

SSH is a key enabled feature and will not be displayed on the Main menu if the feature has not been key-enabled. For additional information, see "Key Enabled Features" on page 4-29.

SSH Navigation
From the Main Menu, select: > SSH > Configure SSH > Load Keys > Key Generator > Key Generator Status

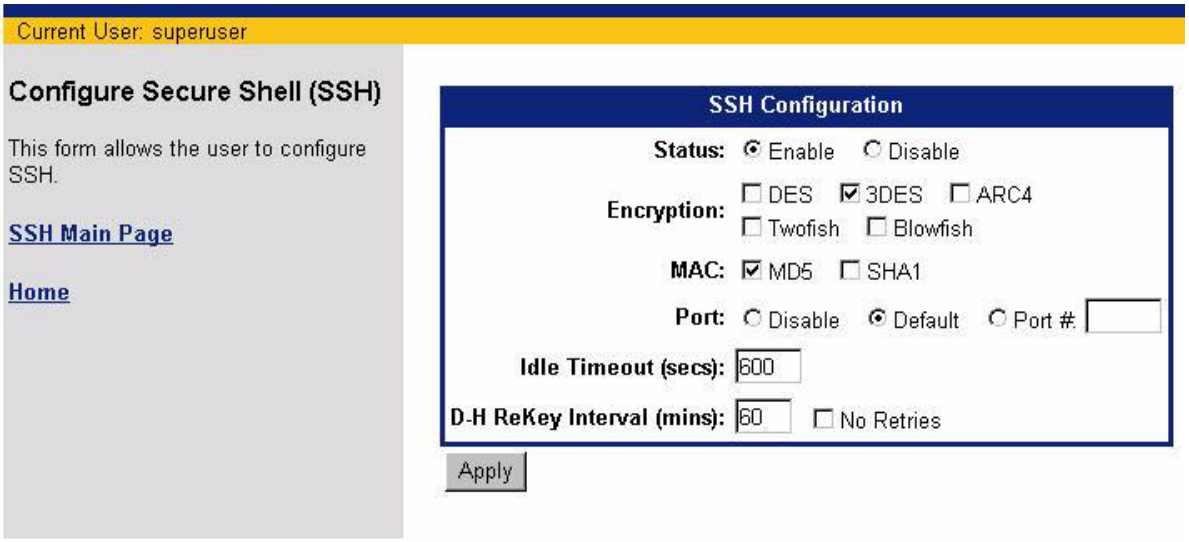
Secure Shell (SSH) Configuration List Page

The *SSH Configuration List* page displays the current SSH configuration settings as well as the links to the other SSH pages. The SSH list page is shown below. For information on the information displayed, see "Secure Shell Configuration page" on page 8-46.



Secure Shell Configuration page

The *SSH Configuration* page (shown below) allows the user to change the modify the current SSH setting.



The following parameters are used for the configuration of SSH.

Status - Enables and disables the SSH feature.

Encryption - Provides for the selection of encryption options supported for SSH communication. The selected method is configured locally on the router (or server). When a client initiates a session, the encryption type is realized and the client adheres to the server encryption mode. If the encryption method is not supported on the client side, the connection will fail. Multiple encryption methods can be selected. For details of each encryption option, see “Encryption Options” on page 5-74.

MAC - Sets the type(s) of Message Authentication Code (MAC) use for SSH connections.

Port - Specifies the port that the SSH server listens on.

Idle Timeout - Sets the idle timeout period (time an SSH connection can remain idle) before the SSH session is disconnected.

D-H ReKey Interval - Specifies the interval at which additional key exchanges will be performed. For more information, see “Re-Key Interval” on page 5-74.

SSH Configuration

To change the current SSH settings, perform the following:

☞ **NOTE:**
Prior to enabling SSH, a private/public key pair should be loaded on the router.

Step 1 In no key pair exists on the router, perform one of the following. If a key pair is loaded, proceed to Step 2.

- Key Generation
- Key Upload

Step 2 From the *SSH Configuration List* page, click the Configure SSH link.

Step 3 As required, configure the SSH settings:

a. Click the select the SSH mode ***Enable*** or ***Disable***.

b. Click the select the ***Encryption method***(s) allowed.

c. Click to select the type(s) of ***Message Authentication Code***.

d. Define the SNMP *Port Number*; click to select one of the following:

- ***Default*** - Returns the SSH port the default value (22) and re-enables SSH after it is disabled.
- ***Disable*** - Disables the SSH port by setting the port to 0.
- ***Port #***, then in the field provided, enter a number to re-define the SSH port (range between 1 and 65535).

e. In the field provided, enter the ***Idle Timeout Period*** (in seconds). (Range between 30 - 1200, 600 seconds is default.)

f. In the field provided, enter the ***ReKey Interval*** (in seconds). (Range between 0 - 600, 600 seconds is default.)

Step 4 Click **Apply** to save the changes.

Step 5 Click the SSH Main page link to return to the SSH Configuration List page. The new settings should now be displayed.

Task Complete

SSH Keys

Diffie-Hellman is the key exchange system used for authentication in the establishment and maintenance of SSH connections. The Key exchange requires a Public key and a Private key that can be generated by the router. For additional information on SSH authentication, see “Key Exchange” on page 5-72.

Key Generation

To generate the key pair, perform the following:

Step 1 From the *SSH Configuration List* page, click the Key Generator link.

Step 2 Read the cautionary statement displayed -

CAUTION:
Executing this function will generate new keys. This function may take in excess of 1 hour to complete. When started, the user will be redirected to a status page which will be refreshed every 60 seconds. The status page will indicate whether the task is running. When the task is no longer running, results will be displayed. Once the task is started, you may monitor key generation via the status page or you may browse to any other pages or you may close the browser. The Keygen function will continue running regardless of the state of your browser.

Step 3 Click **Generate** to generate the keys.

Step 4 To monitor the key generation progress, click the Key Generator Status link from the *SSH Configuration List* page.

Task Complete

You may also generate key files offline and upload them using the Web Management Interface.

CAUTION:
Only SSH corporation’s Key Generation software should be used to generate keys off-line.

Key Upload

To load the key pair, perform the following:

Step 1 From the *SSH Configuration List* page, click the Load Keys link.

Step 2 Click to select the *type* of key file to be loaded (***Public Key*** or ***Private Key***).

Step 3 Select the key file.

a. Click **Browse**.

b. Navigate to the location of the key file.

c. Click to select the ***file***.

d. Click **Open** or other similar function to confirm the file selection.

Step 4 Click **Upload** to load the key file.

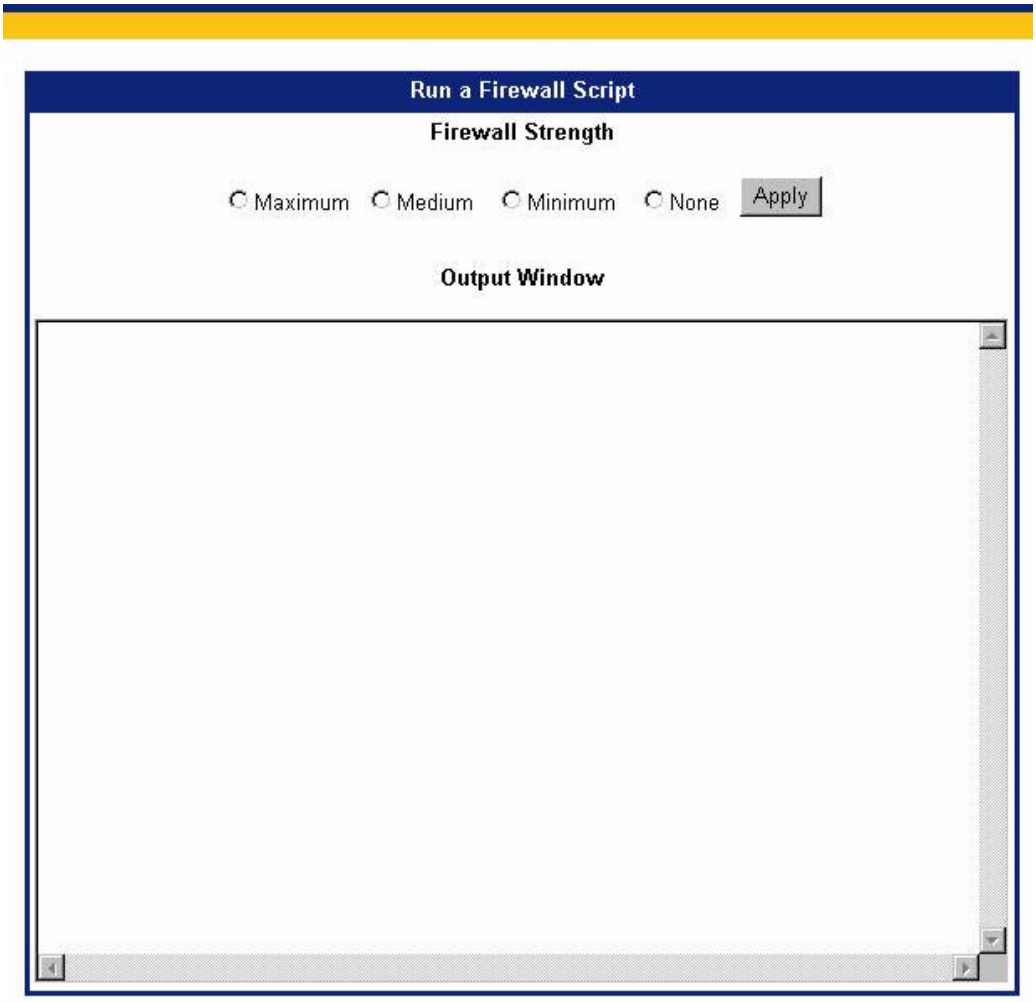
A confirmation message will be displayed upon file upload completion.

Step 5 Click the SSH Main page link to return to the *Secure Shell (SSH) Configuration List* page.

Task Complete

Firewall Scripts

Your router can secure your network and data communications with built-in firewall capabilities. A firewall is any combination of hardware and software that secures a network and traffic to prevent interception or intrusion. For additional information on IP filtering and firewalls, see “IP Filtering” on page 5-23.



The router is equipped with predefined scripts that can be modified or used directly to construct firewalls. The four firewall options available are:

- **Maximum**: Establishes a firewall with the most restrictive policies for maximum network security.
- **Medium**: Establishes a firewall with flexible policies for a moderate level of network security.
- **Minimum**: Establishes a firewall with a basic set of policies for a minimum level of network security.
- **None**: No firewall.

CAUTION:

All network security efforts, including firewall configurations, should be performed by an experienced and qualified network security technician, who is familiar with the unique architecture and requirements of your network. Efficient Networks cannot be liable for security violations due to inadequate or incorrect firewall configurations.

To load a firewall script, perform the following:

Step 1 Click the radio button to select the desired ***Firewall Strength***.

Step 2 Click **Apply**.

The firewall script (commands executed) will be displayed in the *Output Window* and a *confirmation message* is displayed.

Step 3 Click Home to return to the Router Information Page.

Task Complete

QoS

QoS is a key enabled feature and will not be displayed on the Main menu if the feature has not been key-enabled. For additional information, see “Key Enabled Features” on page 4-29.

QoS Navigation
From the Main Menu, select: > QoS (Configuration page) > QoS Policy page

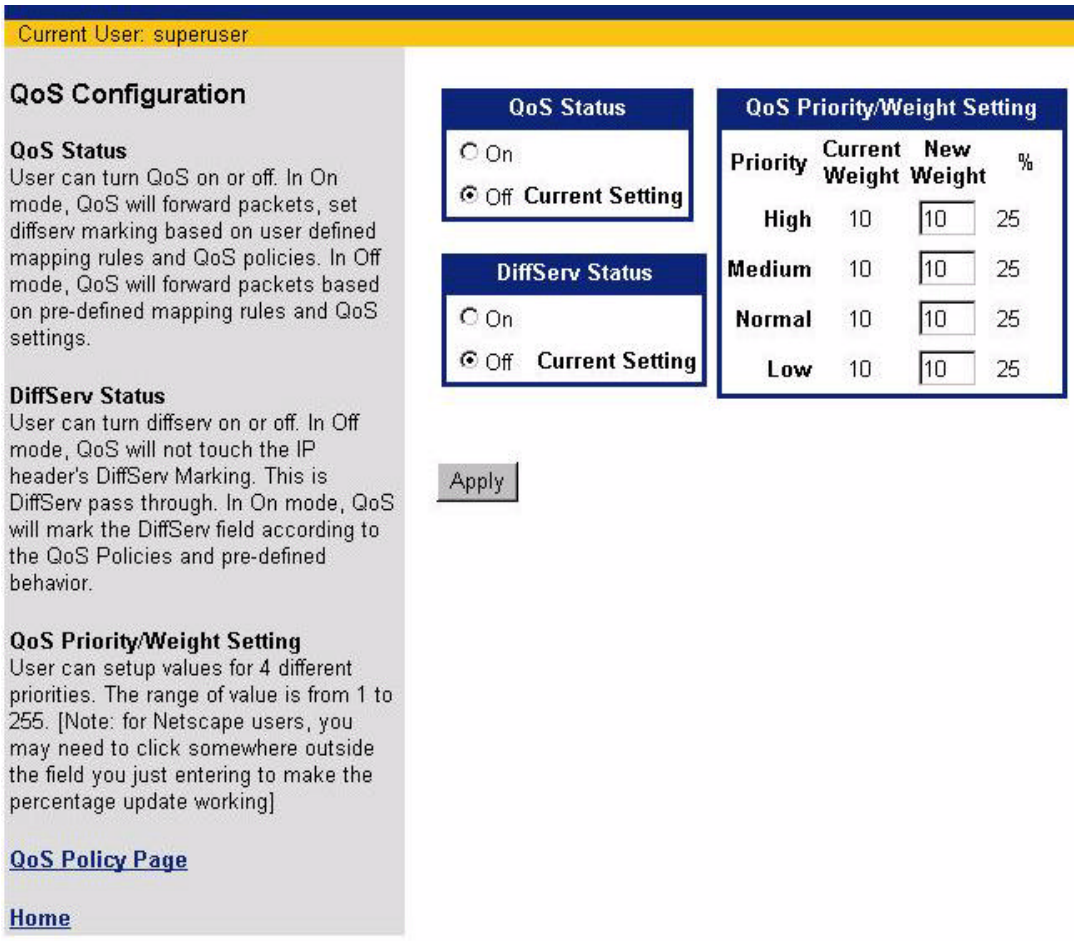
QoS Configuration Page

The *QoS Configuration* page allows viewing and configuration of the current QoS settings as well as access to the QoS Policy Page. These settings include:

QoS Status - Enables (On) and disables (Off) the QoS function. When ON, QoS will forward packets, set diffserv marking based on user defined mapping rules and enabled QoS policies. In Off mode, QoS will forward packets based on pre-defined mapping rules and QoS settings.

DiffServ Status - Enables (On) and disables (Off) marking of the Differentiated Services (DiffServ) field of the IP header. In On mode, QoS will mark the DiffServ field according to the QoS Policies and pre-defined behavior. In Off mode, no DiffServ Marking; this is DiffServ pass through.

QoS Priority/Weight Setting - Assigns values for 4 different priorities. The range of value is from 1 to 255.



To change the current settings, perform the following as required:

Step 1 Click to select a ***QoS Status***.

Step 2 Click to select a ***DiffServ Status***.

Step 3 Enter a new value for the desired ***Threshold Setting*** in the field provided.

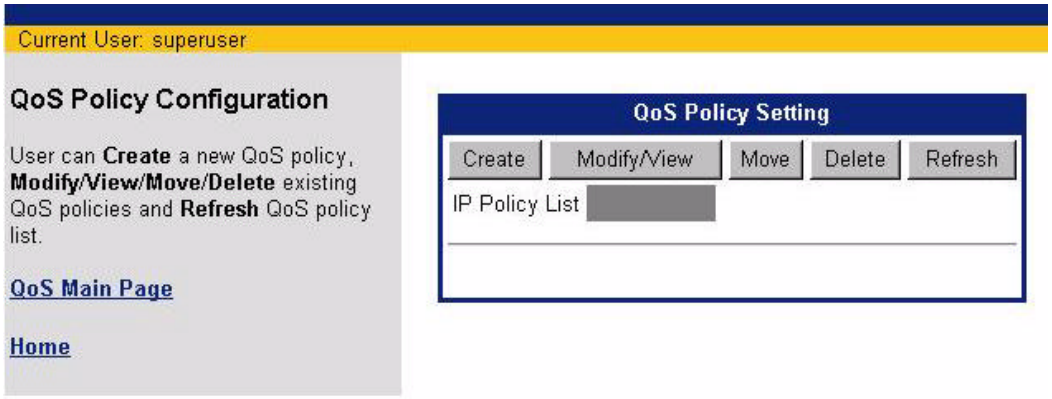
Step 4 Click **Apply**.

Task Complete

QoS Policy Configuration page

The *QoS Policy Configuration* page (shown below) provides a menu that allows the user to:

- Create new QoS policies
- View or modify existing QoS policies
- Delete existing QoS policies
- Move QoS policies
- Refresh the QoS policies lists



QoS Policy Parameters

The following parameters are used in the creation or modification of QoS policies.

Policy Name - Defines the specific policy.

Status - Enables and disables the QoS policy.

Source IP - Specifies the source IP address or range of IP addresses. *Do Not care* will disable source address checking.

Dest IP - Specifies the destination IP address or range of IP addresses. *Do Not care* will disable destination address checking.

Protocol - Specifies the protocol by protocol number or explicitly *TCP* or *UDP*. Selecting *Do Not Care* will disable the protocol check.

Source Port - Specifies the source port or range of ports by number or specific application. *Do Not care* will disable source port checking.

Dest Port - Specifies the destination port or range of ports by number or specific application. *Do Not care* will disable destination port checking.

Priority - Specifies the policy priority, with *normal* the default value.

Code Point - incoming - Specifies or defaults the incoming code point.

Code Point - outgoing - Specifies or defaults the outgoing code point.

Bidirection - Enables (On) and disables (Off) bidirectional operation of the policy.

Start Time - Specifies the time of day when the specified policy becomes active.

Duration - Specifies the time period for the policy to remain active.

Repetition - Specifies the policy as a one-time, repeating, or always-on policy.

QoS Policy Deletion

To delete a QoS policy, perform the following:

Step 1 From the *QoS Configuration* page, click the link to display the *QoS Policy Configuration* page.

Step 2 Click **Delete** on the *QoS Policy Setting Menu*.

The following configuration form will be displayed:

Step 3 Select a delete option.

a. Click to select ***all policies from the IP policy list*** or

b. Click to select ***policy***, then enter the ***policy name*** in the field provided.

Note: Current policy names can be viewed using the IP Policy List pull-down menu.

Step 4 Click **Apply** to save the changes.

Task Complete

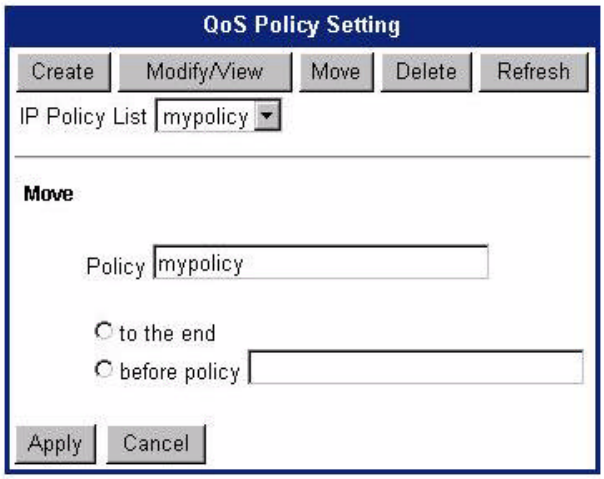
QoS Policy Order

To move a QoS policy, perform the following:

Step 1 From the *QoS Configuration* page, click the link to display the *QoS Policy Configuration* page.

Step 2 Click **Move** on the *QoS Policy Setting Menu*.

The following configuration form will be displayed:



Step 3 In the field provided, specify the ***Policy*** name to be moved.

Step 4 Specify the new policy location.

a. Click to select ***to the end*** - this will move the specified policy to the end of the policy list, or

b. Click to select ***before policy***, then enter the ***policy name*** in the field provided. The policy will be moved to the location immediately preceding the *specified policy*.

Note: Current policy names can be viewed using the IP Policy List pull-down menu.

Step 5 Click **Apply** to save the changes.

Task Complete

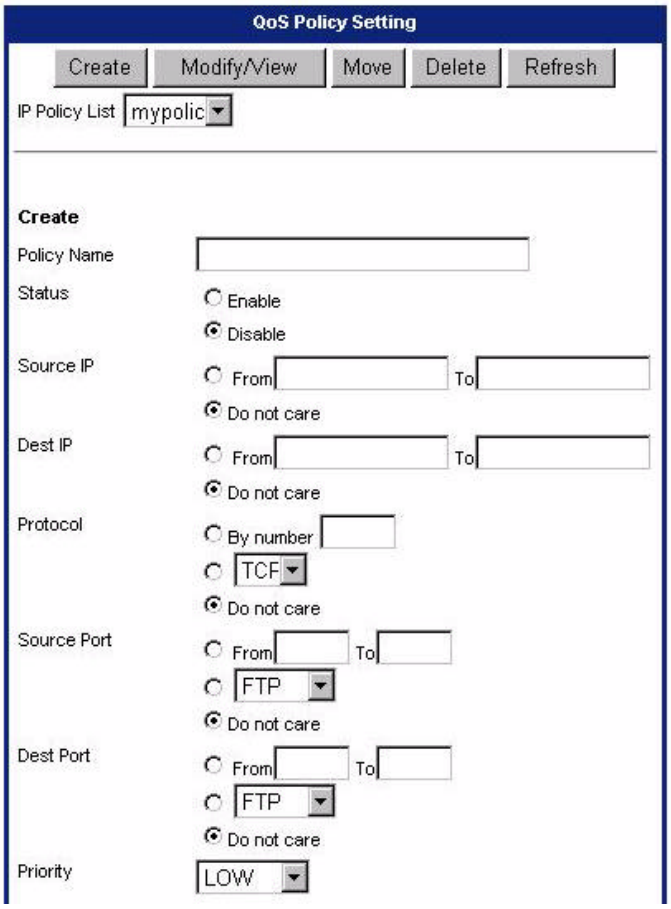
QoS Policy Creation

To create a new QoS policy, perform the following.

Step 1 From the *QoS Configuration* page, click the link to open the *QoS Policy Configuration* page.

Step 2 Click **Create**.

The following *Qos Configuration* form will be displayed.



Step 3 Configure the parameters as required. For specific information on parameters, refer back to ‘QoS Policy Parameters” on page 8-55.

Step 4 Click **Save**.

Task Complete

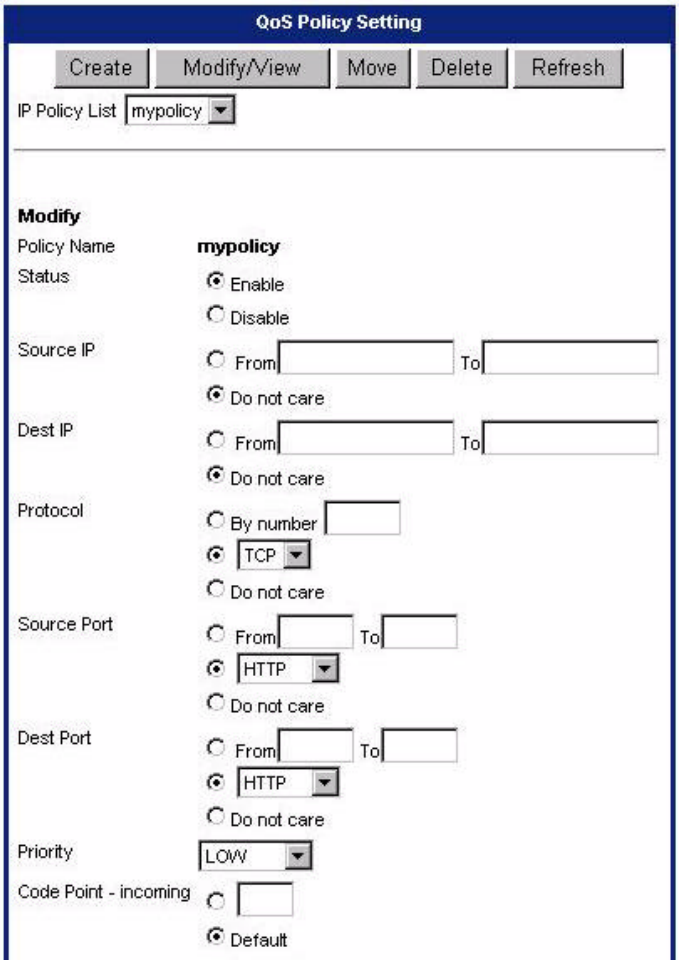
Qos Policy Modification

To modify (or view) an existing QoS policy, perform the following.

Step 1 From the *QoS Configuration* page, click the link to open the *QoS Policy Configuration* page.

Step 2 Click **Modify/Display**.

The following *QoS Policy Configuration* form will be displayed.



a. To exit this form with out saving changes, click **Cancel**.

Step 3 Modify the parameters as required. For specific information on parameters, refer back to ‘QoS Policy Parameters” on page 8-55.

Step 4 Click **Save**.

Task Complete

Stateful Firewall

An IP filtering firewall examines the packet's header information and matches it against a set of defined rules. If it finds a match, the corresponding action is performed. If not, the packet is accepted. The stateful firewall varies from the IP Filtering Firewall in that it gathers and maintains state information about each session. The firewall intercepts outgoing packets and gathers enough information from them (for example IP address information, port number, etc.) and creates the state information for that session. When an incoming packet is seen, it checks the packet against the state information it has maintained, and if the packet belongs to this session, it is accepted. Thus, by tracking and controlling the flow of information through the firewall, the stateful firewall provides robust security.

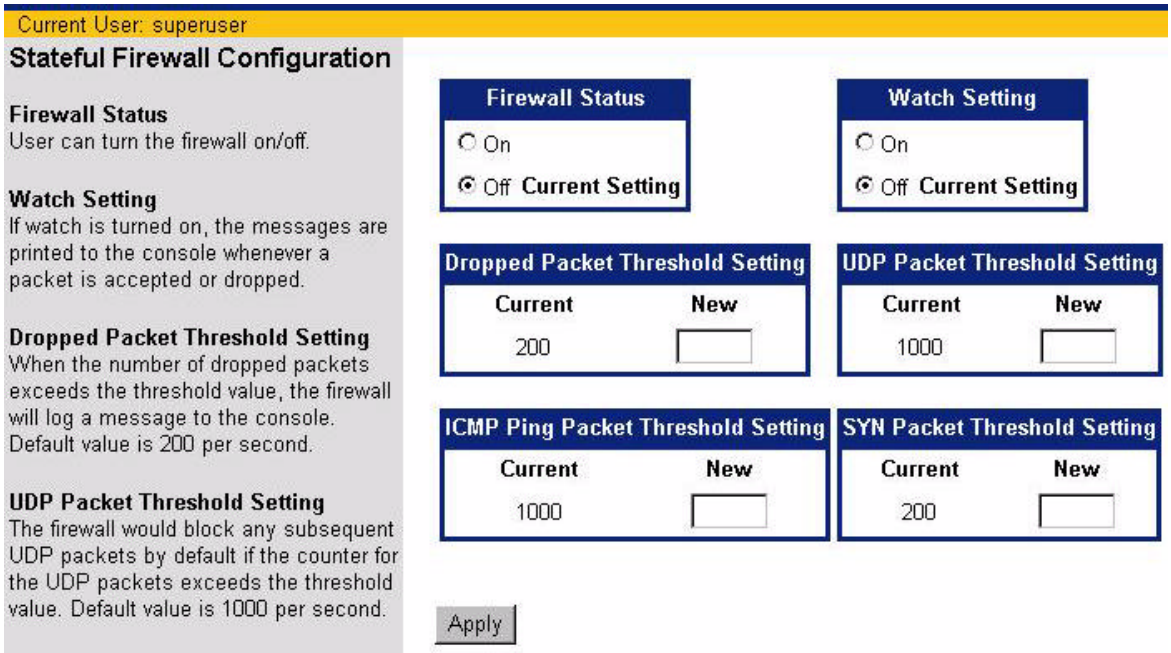
Stateful firewall is a key enabled feature and will not be displayed on the Main menu if the feature has not been key-enabled. For additional information, see "Key Enabled Features" on page 4-29.

Stateful Firewall Navigation
From the Main Menu, select: > Stateful Firewall (Configuration page) > Dropped Packets page > Firewall Rule page

Stateful Firewall Configuration Page

The *Stateful Firewall Configuration* page allows viewing and configuration of the current firewall settings as well as access to the Dropped Packet Page and the Firewall Rule Page. These settings include:

- **Firewall Status** - Indicates the current Firewall mode (on/off).
- **Watch Setting** - If watch is mode is On, a message is printed to the console whenever a packet is accepted or dropped.
- **Dropped Packet Threshold Setting** - When the number of dropped packets exceeds the threshold value, the firewall will log a message to the console. Default value is 200 per second.
- **UDP Packet Threshold Setting** - The firewall would block any subsequent UDP packets by default if the counter for the UDP packets exceeds the threshold value. Default value is 1000 per second.
- **ICMP Ping Packet Threshold Setting** - The firewall would block any subsequent ICMP ping packets by default if the counter for the ICMP ping packets exceeds the threshold value. Default value is 1000 per second.
- **SYN Packet Threshold Setting** - The firewall would block any subsequent SYN requests to a destination by default if the counter for the SYN packets for that destination exceeds the threshold value. Default value is 200 per second.



To change the current settings, perform the following as required:

Step 1 Click to select the new ***Firewall Status***.

Step 2 Click to select the new ***Watch Setting***.

Step 3 Enter a new value for the desired ***Threshold Setting*** in the field provided.

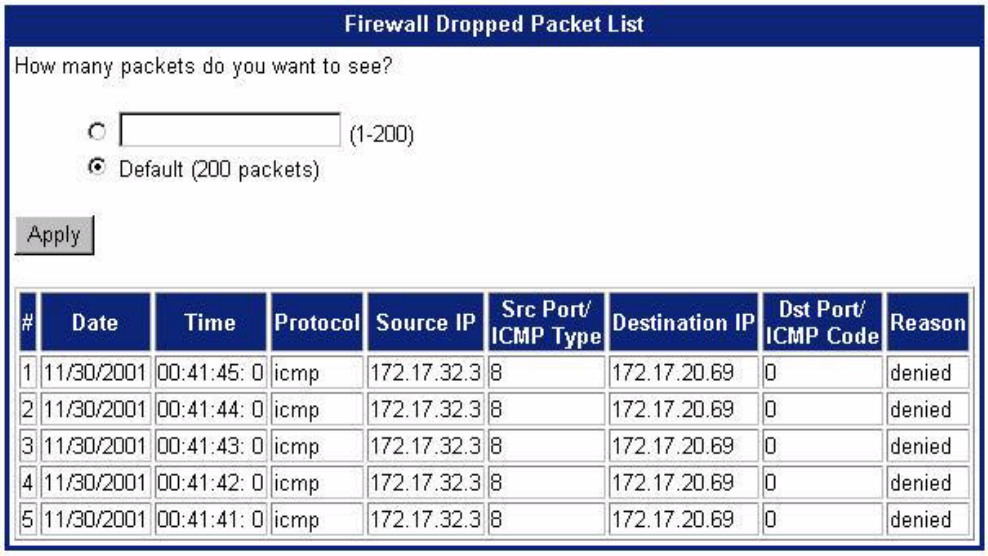
Step 4 Click **Apply**.

Task Complete

From the *Stateful Firewall Configuration* Page access is also provided to the access to the Dropped Packet Page and the Firewall Rule Configuration page.

Dropped Packet Page

The *Dropped Packet* page allows the user to view the last few dropped packets. The user can view up to 200 dropped packets. The *Dropped Packet List* area is shown below.



#	Date	Time	Protocol	Source IP	Src Port/ ICMP Type	Destination IP	Dst Port/ ICMP Code	Reason
1	11/30/2001	00:41:45: 0	icmp	172.17.32.3	8	172.17.20.69	0	denied
2	11/30/2001	00:41:44: 0	icmp	172.17.32.3	8	172.17.20.69	0	denied
3	11/30/2001	00:41:43: 0	icmp	172.17.32.3	8	172.17.20.69	0	denied
4	11/30/2001	00:41:42: 0	icmp	172.17.32.3	8	172.17.20.69	0	denied
5	11/30/2001	00:41:41: 0	icmp	172.17.32.3	8	172.17.20.69	0	denied

☞ **NOTE:**

For Netscape 4 users, you may have to wait for a very long time to get the list displayed. Please select a smaller value.

To view the most recent dropped packets, perform the following:

Step 1 Select the number of dropped packets to view:

a. Click to select a ***user defined value***, then

b. Enter a ***value*** (200 max.) in the field provided, or

c. Click to select the ***Default*** setting (200 packets)

Step 2 Click **Apply**.

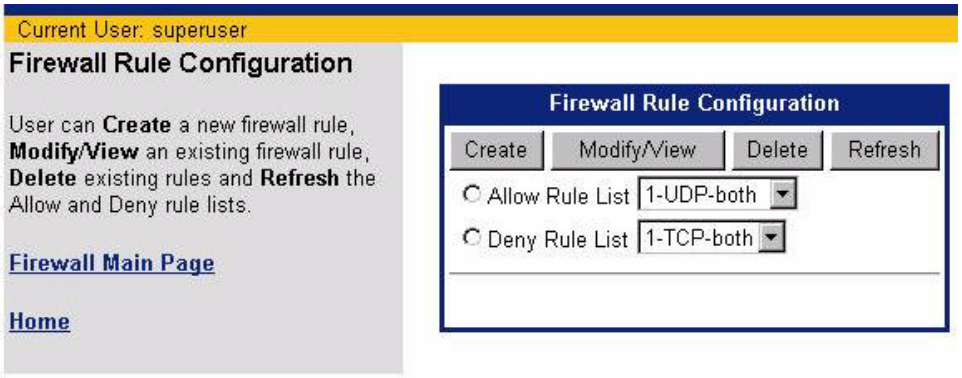
The Drop packet information is displayed.

Task Complete

Firewall Rule Configuration page

The *Firewall Rule Configuration* page (shown below) provides a menu that allows the user to:

- Create new firewall rules
- View or modify existing rules
- Delete existing rules
- Refresh the Allow and Deny Rule lists



Firewall Rule Parameters

The following parameters are used in the creation or modification of Stateful Firewall Rules. For additional information, see “Stateful Firewall” on page 5-34.

Rules List - When firewall rules are created, they are specified as *Allow* or *Deny* rules. When a packet is evaluated, the Deny rules are applied first, then the Allow rules.

Target - This selection specifies the *Protocol/Port* or *Application* characteristics a packet must have in order to match the firewall rule. When Protocol/Port is selected, additional characteristics that an IP packet must have in order to match the firewall rule can be specified.

> **Protocol** - The protocol selections available are *tcp*, *udp*, *icmp* or a protocol *number* can be specified.
>
> If the protocol is *ICMP*, the packet source must match the specified ICMP *Type*. If the packet is *TCP* of *UDP*, if only one source port is specified, the packet must have the specified port, or if a range is defined, a source port that is within the specified port range. If no source port is specified, the firewall rule matches any source port in the range 0 - 65535.
>
> If the protocol is *ICMP*, the packet destination must match the specified ICMP *Code*. If the packet is *TCP* or *UDP*, if only one port is specified, the packet must have the specified destination port, or if a range is defined, a port that is within the specified destination port range. If no destination port is specified, the firewall rule matches any destination port in the range 0 - 65535.

Address - These parameters define the source and destination IP address boundaries that will be applied to the firewall rules.

Source /Destination IP address - The packet must have a source (or destination) IP address within the specified address range. If only one address is specified, the packet must have that source (or destination) IP address. If no source (or destination) IP address is specified, the firewall rule matches any valid IPV4 address.

Source / Destination Mask - The firewall rule uses the specified mask when comparing the source (or destination) IP address range with the IP address in the IP packet. If no mask is specified, the mask used is 255.255.255.255.

Mode - Specifies when watch messages are displayed for this firewall rule. The messages are sent to the console serial port and a Syslog server, if configured. The options are:

Quiet stipulates no messages are displayed for this firewall rule, even if the rule causes a packet to be dropped. This is the default setting for firewall *allow* rules.

Verbose specifies a message is displayed every time this firewall rule matches a packet, regardless of the rule action.

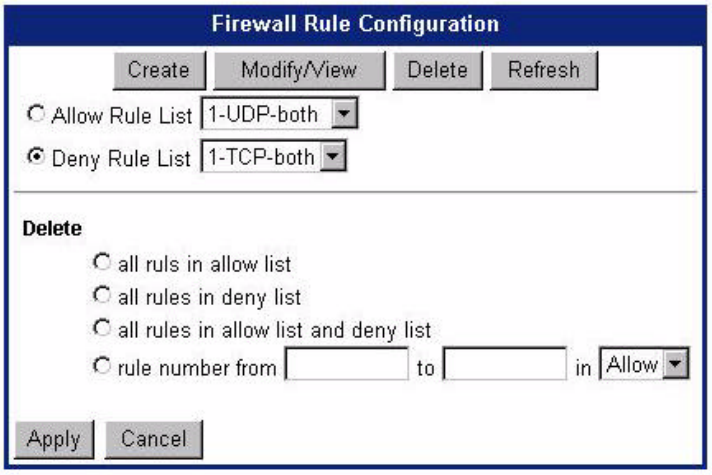
Direction - Specifies the direction of the packet to which the firewall rule is applied. The direction default is *both*.

Firewall Rule Deletion

To delete a firewall rule, perform the following:

Step 1 Click **Delete** on the Firewall Configuration Menu.

The following configuration form will be displayed:



Step 2 Click to select the *appropriate rules* to delete.

To delete a single rule or range of rules:

a. Click to select ***rule number from... to..***.

☞ **NOTE:**

When entering a range of rules to be deleted, the rule range specified is inclusive of the first and last rules.

b. In the first field, enter the ***rule*** (or first rule of the range of rules) to delete. If deleting only a single rule, proceed to Step d.

c. In the second field, enter the ***last rule*** in the range of rules to be deleted. Leave this field empty if only a single rule (specified in the first field) is to be deleted.

d. From the pull-down menu, select the ***rules list*** form which the rule(s) will be deleted.

Step 3 Click **Apply**.

Task Complete

Firewall Rule Creation

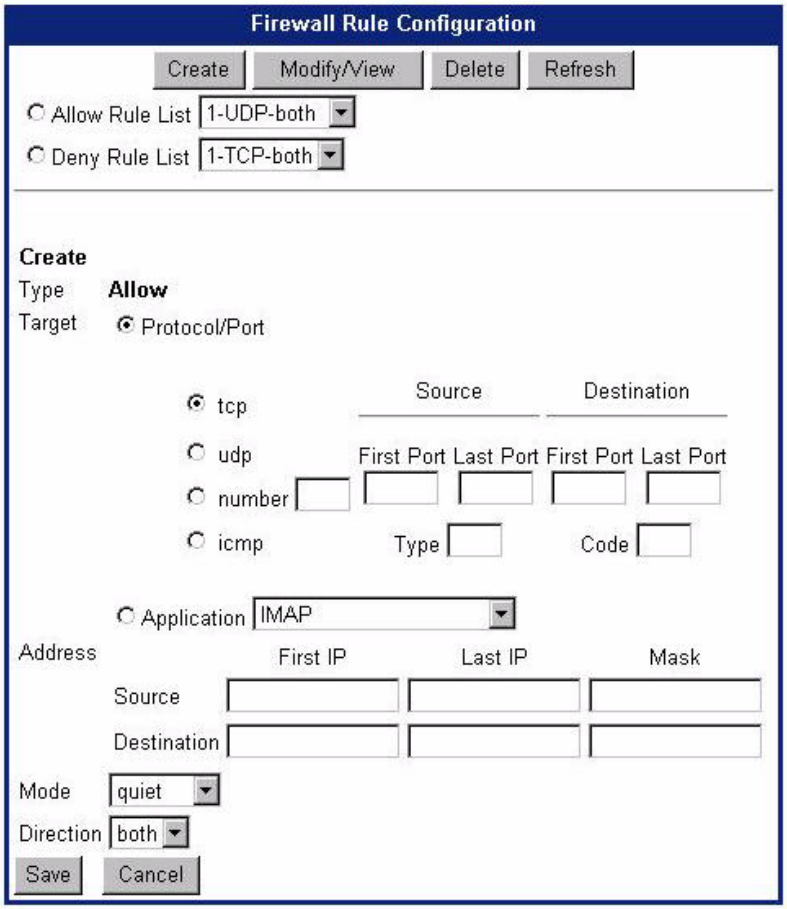
To create a new stateful firewall rule, perform the following.

Step 1 Click to select the *list* the to which the rule will be added:

- ***Allow Rules List***
- ***Deny Rules List***

Step 2 Click **Create**.

The following *Firewall Rule Configuration* form will be displayed.



Step 3 Configure the parameters as required. For specific information on parameters, refer back to ‘Firewall Rule Parameters” on page 8-63.

Step 4 Click **Save**.

Task Complete

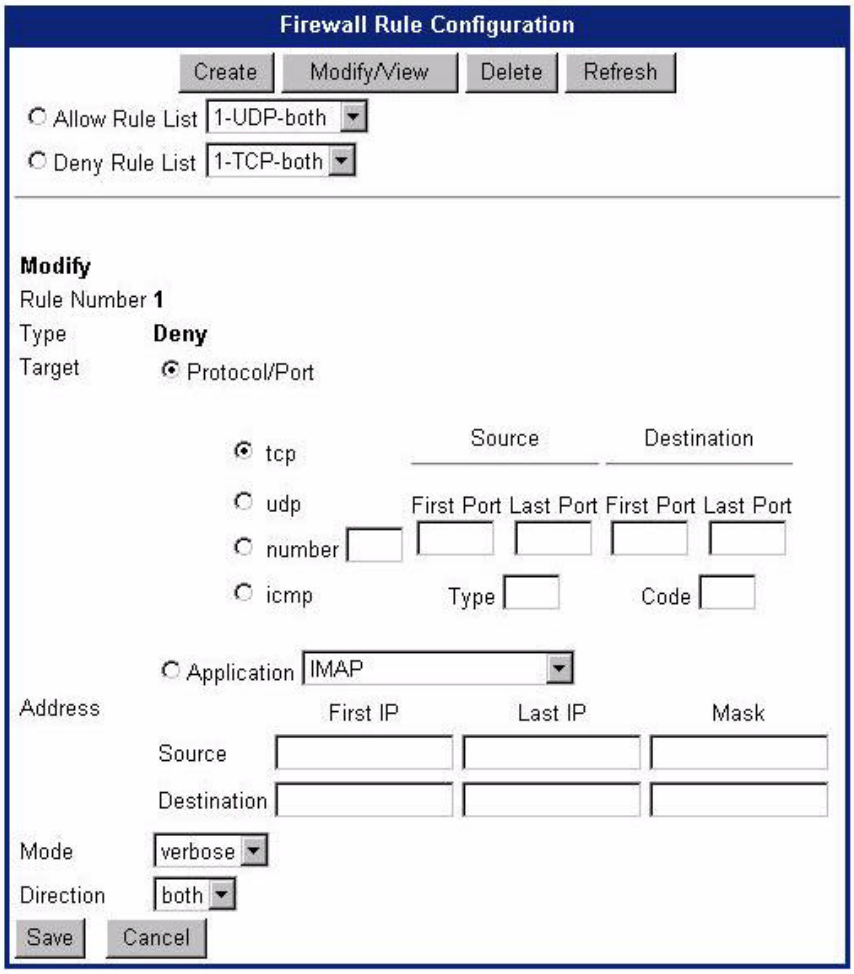
Firewall Rule Modification

To modify (or view) an existing stateful firewall rule, perform the following.

Step 1 From the appropriate pull-down menu, select the ***rule*** be modified.

Step 2 Click **Modify/Display**.

The following *Firewall Rule Configuration* form will be displayed.



a. To exit this form with out saving changes, click **Cancel**.

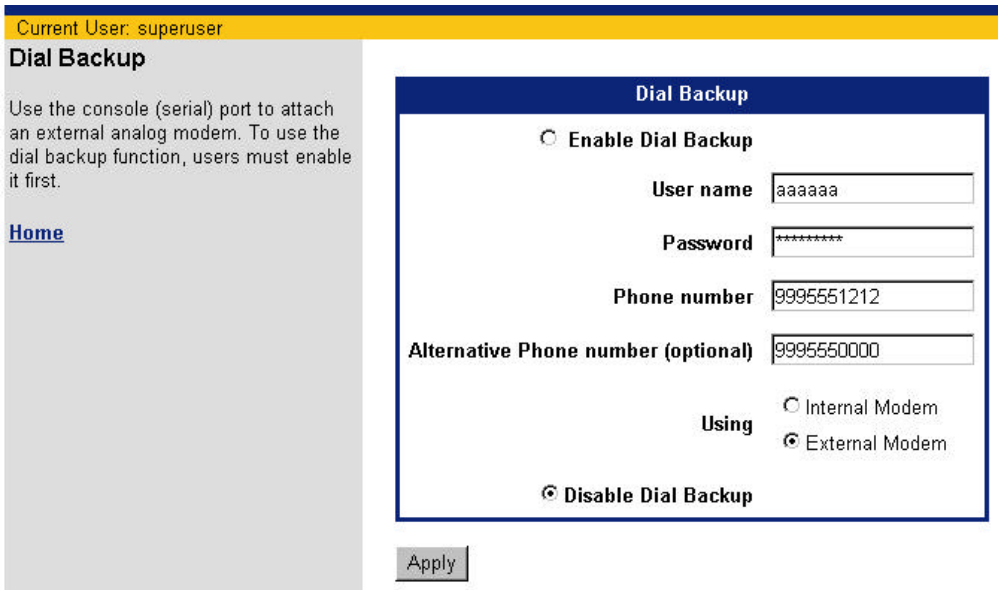
Step 3 Modify the parameters as required. For specific information on parameters, refer back to ‘Firewall Rule Parameters” on page 8-63.

Step 4 Click **Save**.

Task Complete

Dial Backup

Dial Backup, when enabled, provides a backup connection to the Internet through an external V.90 or ISDN modem. If your router is equipped with an internal modem and the Feature Key is present, the backup connection uses the internal modem; otherwise the backup connection uses an external modem connected to the console port of the router. This backup connection can be activated in the event of a DSL service interruption. During a DSL interruption, the router will use the dialup modem connection while waiting for DSL service to be restored. Once the DSL link is active again, Dial Backup will automatically switch back to the DSL service. For more information, see "Dial Backup" on page 6-7.



To enable Dial Backup, perform the following steps:

Step 1 Click to select ***Enable Dial Backup***.

Step 2 Enter your ***User name*** in the field provided (provided from your ISP).

Step 3 Enter your ***Password*** in the field provided (provided from your ISP).

Step 4 Enter *ISP dialup information*.

a. In the field provided, enter ISP's dial-up ***Phone number***.

b. Optional, in the field provided, enter an ***Alternate Phone number***.

Step 5 If applicable, click to select the modem you are **Using**: *Internal* or *External modem*

Step 6 Click **Apply**.

The *Dial Backup Configuration* page is displayed.

Step 7 Enter the ***Reset DSL Timer value*** in the field provided.

This timer specifies how often to check to see if the DSL link has been restored.

Step 8 In the field provided, enter the ***Backup Failover Timeout*** value.

This parameter defines a time period which guards against too frequent switching back and forth between the DSL link and the backup port. The default Failover period is three minutes.

Step 9 Enter ***IP Addresses*** in the field provided.

The IP Addresses are the addresses the router uses to ping via the DSL link. If the ping tests fail, the router switches data traffic to the backup port until the retry period expires again.

Step 10 Enter ***Ping Success Rate*** in the field provided.

The Ping Success Rate applies to all addresses defined in "*IP Address*" field. As soon as the rate of successful pings (of all IP addresses) falls below the "Ping Success Rate", the DSL link is assumed to have failed and the switchover to the backup is performed.

☞ **NOTE:**

If you are using the internal modem option, the information in the next two steps is preconfigured; proceed to Step 13.

Step 11 Enter ***Serial Port Data Rate*** in the field provided.

The Serial Port Data Rate specifies the bit rate used through interface to the modem.

Step 12 In the fields provided, enter the

a. ***Modem Initialization String***.

b. ***Modem Dial String***

The *Modem Initialization String* and *Modem Dial String* are modem parameters specified by the modem manufacturer in the modem documentation.

Step 13 Click **Save and Reboot** to reboot enable the changes.

Task Complete

To disable Dial Backup, perform the following steps:

Step 1 Click to select ***Disable Dial Backup***.

Step 2 Click **Apply**.

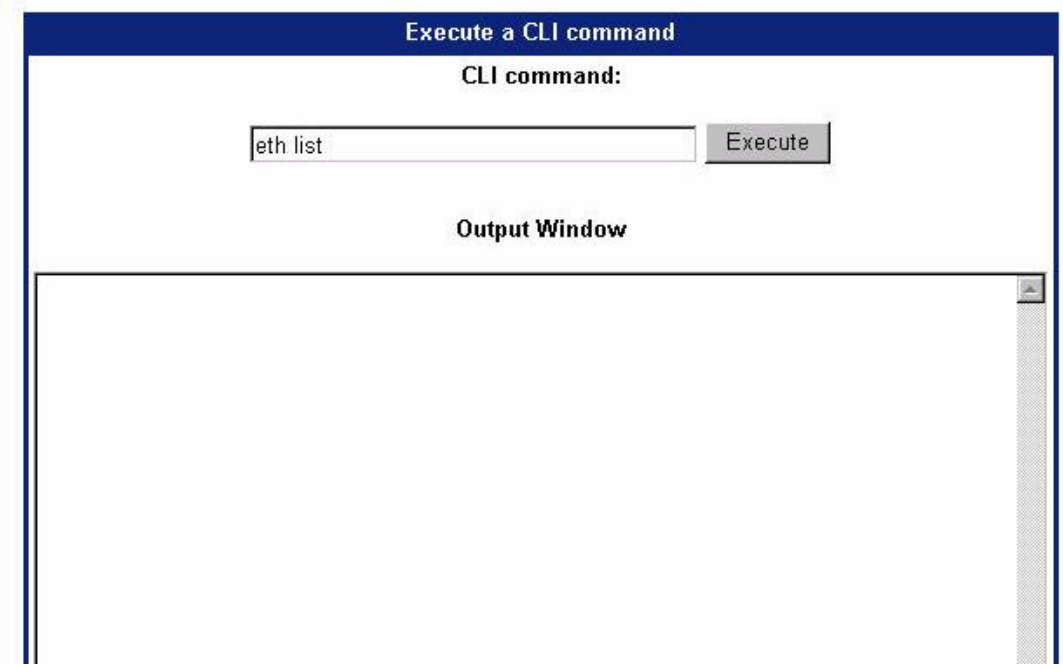
Step 3 Click the Home link to return to the Router Information Page.

Step 4 Click **Reboot Router** to reboot enable the changes.

Task Complete

Command Line Interface

Command Line Interface page allows the user to enter any CLI command over the web interface. For complete command line syntax, refer to the Command Line interface Guide. The functional area of the WMI, *Command Line Interface* is shown below.



To execute CLI command, perform the following:

Step 1 In the field provided, enter the ***CLI command***.

Step 2 Click **Execute**.

The response will be displayed in the *Output Window*.

Task Complete

Web Management Interface Privileges

The following table indicates the access privileges required for viewing or executing functions and features via the WMI.

Table 8-1: WMI Access Privilege

WMI Page	Read-Only	Read/Write
index.html (default page)	Any - Read	NA
bronly.html	Data or Wan - Read	Data or Wan - Write
dhcp.html	Security - Read	Security - Write
filter.html	Data - Read	Data - Write
ipxroutes.html	Data - Read	Data - Write
lan.html	Data - Read	Data - Write
proto-14xx.html	Data - Read	Data - Write
proto-14xxmer.html	Data - Read	Data - Write
proto-ppp.html	Data - Read	Data - Write
proto-pppoe.html	Data - Read	Data - Write
quick.html	Data - Read	Data - Write
wan.html	Data - Read	Data - Write
config.html	Data - Read	Data - Write
tools/index.html	Data - Read	NA
tools/access.html	Security - Read	Security - Write
tools/nat.html	Data - Read	Data - Write
tools/links.html	Any - Read	Any - Write
tools/strings.html	Debug - Read	Debug - Write
tools/dump.html	Debug - Read	Debug - Write
tools/password.html	Any - Read	None
tools/newpass.html	Any - Read	None
tools/routing.html	Data - Read	Data - Write
tools/upload.html	Admin - Read	Admin - Write
tools/download.html	Any - Read	Any - Write
tools/time.html	Any - Read	Any - Write
tools/editor.html	Admin - Read	Admin - Write
tools/reboot.html	NA	Any - Write
tools/default.html	NA	Admin - Write
tools/factory.html	NA	Admin - Write
tools/firewall.html *	Security - Read	Security - Write
tools/cli.html *	None	None

Table 8-1: WMI Access Privilege

WMI Page	Read-Only	Read/Write
tools/dhcp.html	Data - Read	Data - Write
tools/diag.html *	None	None
tools/syslog.html	Inventory - Read	Inventory - Write
tools/setupDBUP.html	Data - Read	Data - Write
tools/configDBUP.html	Data - Read	Data - Write
lib/index.html	Any - Read	NA
lib/basic.html	Debug - Read	Debug - Write
lib/js_lib.html	Any - Read	Any - Write
kef/keflist.html	Any - Read	NA
kef/kefadd.html	Any - Read	Any - Write
kef/kefdel.html	Admin - Read	Admin - Write
kef/kefenable.html	Any - Read	Any - Write
kef/kefrevoke.html	Any - Read	Any - Write
kef/kefunrevoke.html	Any - Read	Any - Write
kef/kefupdate.html	Any - Read	Any - Write
admin/selectuser.html	Admin - Read	Admin - Write
admin/user.html	Admin - Read	Admin - Write
admin/user_novoice.html	Admin - Read	Admin - Write
admin/no_access.html	Admin - Read	Admin - Write
admin/no_access.html	Admin - Read	Admin - Write
admin/userlookup.html	Admin - Read	Admin - Write
ipsec/index.html	Security - Read	NA
ipsec/strings.html	Security - Read	NA
ipsec/links.html	Security - Read	NA
ipsec/ike_advanced.html	Security - Read	NA
ipsec/ike.html	Security - Read	Security - Write
ipsec/ike_peer.html	Security - Read	Security - Write
ipsec/ike_mode.html	Security - Read	Security - Write
ipsec/ike_prop.html	Security - Read	Security - Write
ipsec/ike_ips_prop.html	Security - Read	Security - Write
ipsec/ike_ips_poli.html	Security - Read	Security - Write
ipsec/ike_proc.html	Security - Read	Security - Write
ipsec/ike_simple.html	Security - Read	Security - Write
ipsec/ike_result.html	Security - Read	Security - Write
ipsec/ipsec.html	Security - Read	Security - Write

Table 8-1: WMI Access Privilege

WMI Page	Read-Only	Read/Write
tools/loopGround.html	Voice - Read	Voice - Write
tools/stdSignal.html	Voice - Read	Voice - Write
tools/features.html	Any - Read	Any - Write
firewall/index.html	Security - Read	Security - Write
firewall/stateful_firewall.html	Security - Read	Security - Write
firewall/ stateful_firewall_rule.html	Security - Read	Security - Write
firewall/ stateful_firewall_dropped.ht-ml	Security - Read	Security - Write
qos/index.html	Data - Read	Data - Write
qos/qos.html	Data - Read	Data - Write
qos/qos_policy.html	Data - Read	Data - Write
ssh/sshlist.html	Security - Read	NA
ssh/sshkeygen.html	Security - Read	Security - Write
ssh/keygencomp.html	Security - Read	Security - Write
ssh/sshkeygenstatus.html	Security - Read	Security - Write
ssh/sshload	Security - Read	Security - Write
ssh/sshconfig	Security - Read	Security - Write

* - These pages pass data to the CLI; the command will be executed in the same class as the actual CLI command. If a security class is specified in the view or submit columns, the user must have those rights to see the page and/or press the apply button. In addition, the command executed will be filtered in the same manner as a CLI command.