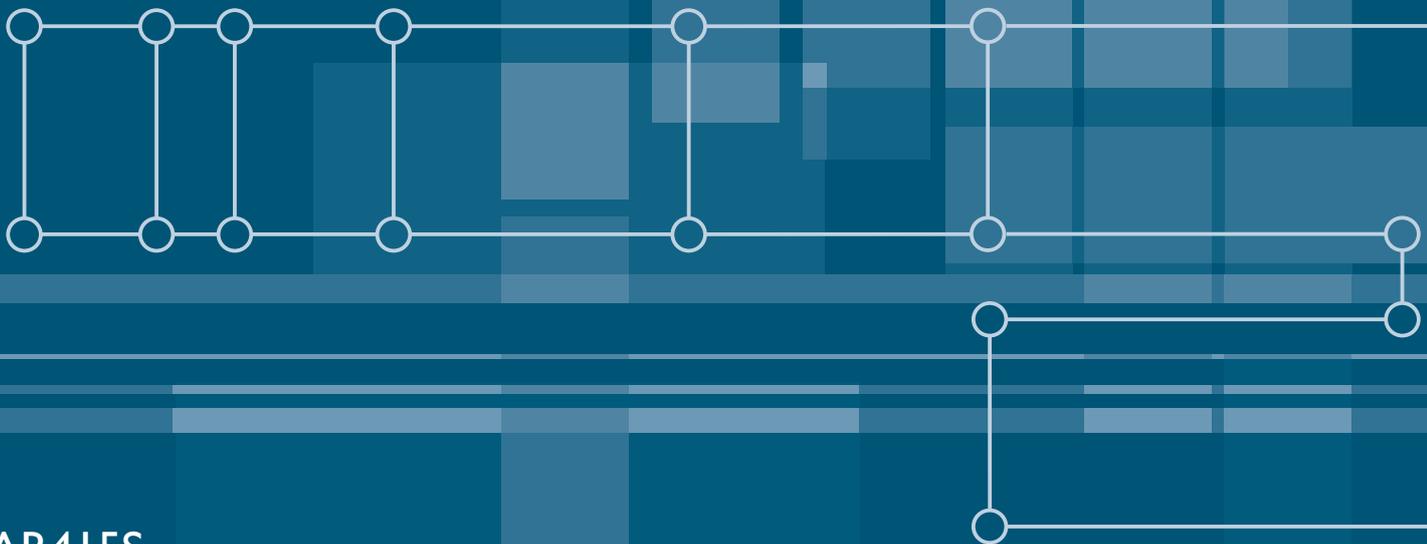


AR400 Series Router
AlliedWare™ Operating System
Software Reference for Version 2.9.1



AR415S
AR440S
AR441S
AR442S
AR450S

AlliedWare OS Software Reference for Software Version 2.9.1
Document Number C613-03124-00 REV A.

© 2007 Allied Telesis, Inc. All rights reserved. No part of this publication may be reproduced without prior written permission from Allied Telesis, Inc.

Allied Telesis, Inc. reserves the right to make changes in specifications and other information in this document without prior written notice. The information provided herein is subject to change without notice. In no event shall Allied Telesis, Inc. be liable for any incidental, special, indirect, or consequential damages whatsoever, including but not limited to lost profits, arising out of or related to this manual or the information contained herein, even if Allied Telesis, Inc. has been advised of, known, or should have known, the possibility of such damages.

All company names, logos, and product designs that are trademarks or registered trademarks are the property of their respective owners.

Contents

About this Software Reference

Introduction	lix
Structure of this Software Reference	lix
Intended Audience	lxiv
Conventions	lxv
Command Descriptions	lxvi
Where To Find More Information	lxvii
Obtaining Copies of Internet Protocols and Standards	lxviii
Publicly Accessible Documents	lxviii
Allied Telesis Offices and Locations	lxviii
Reader's Comments	lxix

Command Summary

CHAPTER 1 Getting Started

Establishing a Management Session with the Router	1-2
Assigning an IP Address	1-2
About Setting Routes	1-3
Checking Connections with PING	1-3
Changing a Password	1-4
Using Command Line Help	1-4
Using GUI Help	1-5
Special Feature Licences	1-5
Setting System Parameters	1-6
Saving Configurations Entered with the CLI	1-6
Saving Configurations Entered with the GUI	1-7
Troubleshooting Traffic Flow	1-7
Software Upgrades	1-8
SNMP and MIBs	1-8
To Avoid Problems	1-9
For More Information	1-10

CHAPTER 2 Using the Command Line Interface (CLI)

Introduction	2-2
Parts of a Command	2-3
Entering a Command	2-4
Shortcuts	2-4
Command Sets	2-6
What is Valid Syntax?	2-7
What Commands does a Feature Support?	2-9

Editing Commands	2-10
Recalling Commands	2-11
Command Reference	2-12
add alias	2-12
delete alias	2-13
help	2-13
set command assignmentoperator	2-14
set help	2-15
show alias	2-15
show command history	2-16

CHAPTER 3 **Using the Graphical User Interface (GUI)**

Introduction	3-2
What is the GUI?	3-2
Accessing the Router via the GUI	3-3
Browser and PC Setup	3-3
Establishing a Connection to the Router	3-5
Secure Access	3-10
System Status Details	3-11
Using the GUI: Navigation and Features	3-12
Wizards (AR44xS and AR415S)	3-12
The Quick Start Menu (AR450S)	3-12
The Configuration Menu	3-12
Using Configuration Pages	3-13
The Management Menu	3-16
The Monitoring Menu	3-16
The Diagnostics Menu	3-17
Combining GUI and CLI Configuration	3-17
Troubleshooting	3-18
Enabling and Disabling the GUI	3-18
Deleting Temporary Files	3-18
Accessing the Router via the GUI	3-19
Command Reference	3-21
disable gui	3-21
enable gui	3-21
reset gui	3-22
show gui	3-23

CHAPTER 4 **Configuring and Monitoring the System**

Introduction	4-3
System Identification	4-3
Time and Date	4-4
Timezone and UTC Offset	4-5
Monitoring Router Operations	4-6
Emailing Alerts from the Router	4-10
Configuration Examples	4-11
Command Reference	4-13
activate cpu extended	4-13
clear summertime	4-14
clear timezone	4-15
delete mail	4-15
disable cpu extended	4-16
disable debug active	4-17
disable mail debug	4-17
disable summertime	4-18
dump	4-19
enable cpu extended	4-20
enable summertime	4-21

enable mail debug	4-21
mail	4-22
modify	4-24
reset cpu utilisation	4-25
reset mail	4-25
set mail	4-26
set summertime	4-27
set system contact	4-29
set system location	4-30
set system name	4-31
set time	4-32
set timezone	4-33
show buffer	4-34
show cpu	4-38
show debug	4-40
show debug active	4-42
show exception	4-47
show mail	4-48
show startup	4-49
show summertime	4-50
show system	4-51
show system serialnumber	4-54
show system startup	4-55
show time	4-55
show timezone	4-56

CHAPTER 5 **Managing Configuration Files and Software Versions**

Managing Configuration Files	5-3
Loading Files onto the Router	5-4
Loading from a Trivial File Transfer Protocol (TFTP) Server	5-5
Loading from a Web Server	5-5
Loading from a Lightweight Directory Access Protocol (LDAP) Server	5-7
Loading from a Remote Device using Secure Copy	5-8
Additional Loader Commands	5-9
Uploading Files from the Router	5-9
Using HTTP	5-9
Using TFTP and ZMODEM	5-11
Using Secure Copy	5-12
Software Upgrades	5-13
Upgrade Overview	5-13
Install Process	5-14
Filenames	5-15
Licencing	5-15
Patches	5-17
Example: Upgrading to new software	5-17
Example: Upgrading to a new patch file	5-19
Upgrading the GUI	5-20
Command Reference	5-22
create config	5-22
delete install	5-23
disable feature	5-24
disable http debug	5-25
disable http server	5-25
disable ldap debug	5-26
disable release	5-26
enable feature	5-27
enable http debug	5-28
enable http server	5-28

enable ldap debug	5-29
enable release	5-30
load	5-31
purge ldap	5-36
reset http server	5-36
reset loader	5-36
restart	5-37
set config	5-38
set http server	5-39
set install	5-40
set loader	5-42
show config	5-46
show feature	5-48
show http client	5-50
show http debug	5-51
show http server	5-52
show http server session	5-53
show install	5-54
show ldap	5-55
show ldap request	5-56
show loader	5-58
show patch	5-60
show release	5-61
upload	5-62

CHAPTER 6 **Managing the File System**

Introduction	6-2
File Naming Conventions	6-2
Long Filenames in Releases	6-3
Working with Files	6-4
Built-In Editor	6-5
Using Wildcards	6-5
Sending Output to a Text File	6-5
Flash Memory	6-6
The Flash File System (FFS)	6-7
If You Clear Flash Memory Completely	6-8
Command Reference	6-9
activate flash compaction	6-9
add file	6-10
clear flash totally	6-11
copy	6-12
create file	6-13
delete file	6-14
disable flash autowrite	6-15
edit	6-16
enable flash autowrite	6-19
purge file translationtable	6-20
rename	6-21
reset file permanentredirect	6-22
show ffile	6-23
show file	6-25
show file permanentredirect	6-28
show flash	6-29
show flash physical	6-31

CHAPTER 7 **Overview of Physical and Layer 2 Interfaces**

Introduction	7-2
Interfaces	7-3
Naming Interfaces	7-4
Ethernet Ports	7-5
Asynchronous Port	7-5
Asynchronous Call Control (ACC)	7-6
ADSL and ATM (models with ADSL port)	7-7
Synchronous Ports (models with PIC bay)	7-7
Switch Ports	7-8
Port Speed and Duplex Mode	7-8
Packet Storm Protection	7-9
Virtual LANs	7-10
Point to Point Protocol (PPP)	7-11
Dynamic PPP Interfaces and PPP Templates	7-11
PPPoE	7-12
Frame Relay (models with PIC bay)	7-12
Integrated Services Digital Network (ISDN) (models with PIC bay)	7-15
BRI Versus PRI	7-15
Configuring the Basic Rate Interface	7-15
Configuring the Primary Rate Interface	7-15
Default Setup	7-16
Testing the BRI or PRI PIC	7-16
Ordering ISDN in the USA and Canada	7-16
Connecting to a Leased Line Circuit (models with PIC bay)	7-17

CHAPTER 8 **Switching**

Introduction	8-3
Switch Ports	8-4
Enabling and Disabling Switch Ports	8-4
Port Speed and Duplex Mode	8-4
Packet Storm Protection	8-6
Virtual Local Area Networks (VLANs)	8-6
Dynamic VLAN Assignment	8-7
802.1x Guest VLAN	8-8
VLAN Tagging	8-8
VLAN Membership using VLAN Tags	8-11
VLAN Membership of Untagged Packets	8-12
Setting Up VLANs	8-13
Summary of VLAN Tagging Rules	8-14
The Layer 2 Switching Process	8-15
The Ingress Rules	8-15
The Learning Process	8-16
The Forwarding Process	8-17
Quality of Service (QoS)	8-17
The Egress Rules	8-18
Triggers	8-18
Configuration Examples	8-20
One Router to Extend a LAN	8-20
VLAN Using Untagged Ports	8-21
VLAN Using Tagged Ports	8-22
Command Reference	8-25
add vlan port	8-25
create vlan	8-26
delete vlan port	8-27
destroy vlan	8-28
disable switch ageingtimer	8-28
disable switch debug	8-29

disable switch learning	8-29
disable switch port	8-30
disable vlan debug	8-30
enable switch ageing timer	8-31
enable switch debug	8-32
enable switch learning	8-33
enable switch port	8-33
enable vlan debug	8-34
reset switch	8-34
reset switch port	8-35
set switch ageingtimer	8-36
set switch port	8-37
set switch qos	8-40
set vlan port	8-41
show switch	8-42
show switch debug	8-43
show switch counter	8-44
show switch fdb	8-46
show switch port	8-47
show switch port counter	8-49
show switch qos	8-53
show vlan	8-54
show vlan debug	8-56

CHAPTER 9 Interfaces

Introduction	9-3
Naming Interfaces	9-4
Simple Interface Names	9-4
Fully Qualified Interface Names	9-5
Ethernet	9-6
Encapsulations	9-7
Configuration	9-9
Synchronous Interfaces	9-11
Encapsulations	9-12
Modem Control Signals	9-12
Configuration	9-13
Asynchronous Interfaces	9-15
Encapsulations	9-16
Configuration	9-16
Session Timeout	9-19
Connecting a Modem to the Asynchronous Port	9-20
MIB Counters	9-20
Autobauding	9-21
Making Asynchronous Ports Respond More Quickly	9-22
Testing Serial Data Circuits	9-22
Displaying Interfaces	9-23
Interface Link Traps	9-23
Managing Interfaces with SNMP	9-24
Command Reference	9-25
connect asyn	9-25
create eth	9-26
destroy eth	9-26
disable asyn	9-27
disable interface debug	9-28
disable interface linktrap	9-29
disable syn	9-30
disable syn debug	9-30
enable asyn	9-31

enable interface debug	9-31
enable interface linktrap	9-32
enable syn	9-33
enable syn debug	9-33
purge asyn	9-34
reset asyn	9-34
reset asyn counter	9-35
reset asyn history	9-36
reset eth	9-36
reset eth counters	9-37
reset interface counters	9-37
reset syn	9-38
reset syn counters	9-39
set asyn	9-40
set eth linkup	9-45
set eth maxbandwidth	9-46
set eth speed	9-47
set interface mtu	9-48
set interface traplimit	9-49
set syn	9-50
show asyn	9-53
show eth configuration	9-61
show eth counters	9-62
show eth macaddress	9-67
show eth receive	9-68
show eth state	9-69
show interface	9-72
show syn	9-78
show syn counter	9-80
CHAPTER 10 ATM over xDSL	
Introduction	10-3
Digital Subscriber Line Technologies	10-3
ADSL	10-6
SHDSL	10-8
Embedded Operations Channel	10-10
ATM	10-11
ATM Call Admission Control (CAC)	10-13
Typical settings for ATM over ADSL and SHDSL	10-15
Data Layers above ATM	10-16
Connection Types Used over ATM	10-16
RFC 1483 Multiprotocol Encapsulation	10-17
Support on the Router	10-19
Configuration Procedures and Examples	10-20
Configure PPPoE over ATM	10-21
Configure PPP over ATM (PPPoA)	10-24
Configure IP over ATM (IPoA)	10-27
Configure ATM RFC 1483 Routed	10-29
After configuring ATM	10-30
Command Reference	10-31
activate atm channel oamfunction	10-31
activate shdsl eoccmd	10-32
add atm channel	10-34
create atm	10-36
deactivate shdsl eoccmd	10-37
delete atm channel	10-38
destroy atm	10-38
disable adsl	10-39
disable adsl debug	10-39
disable atm cac	10-40

disable atm channel	10-40
disable shdsl	10-41
disable shdsl bert	10-41
disable shdsl debug	10-42
enable adsl	10-42
enable adsl debug	10-43
enable atm cac	10-43
enable atm channel	10-44
enable shdsl	10-44
enable shdsl bert	10-45
enable shdsl debug	10-46
reset adsl	10-48
reset adsl counter	10-48
reset atm channel counter	10-49
reset atm counter	10-49
reset shdsl	10-49
reset shdsl counter	10-50
set adsl	10-51
set atm cac	10-52
set atm channel	10-53
set shdsl	10-55
set system country	10-59
show adsl	10-60
show adsl counter	10-62
show atm	10-66
show atm channel	10-69
show atm counter	10-71
show shdsl	10-74
show shdsl counter	10-78
show shdsl linedetails	10-82

CHAPTER 11 **Integrated Services Digital Network (ISDN)**

Introduction	11-4
Basic Rate Access	11-4
Primary Rate Access	11-8
ISDN on the Router	11-14
BRI Physical Layer	11-16
Configuring and Controlling the Basic Rate Interface	11-16
Examining the Status of the Basic Rate Interface	11-18
Monitoring Operation of the Basic Rate Interface	11-20
PRI Physical Layer	11-20
Configuring and Controlling the Primary Rate Interface	11-21
Examining the Status of the Primary Rate Interface	11-23
Monitoring Operation of the Primary Rate Interface	11-25
LAPD	11-26
BRI Versus PRI	11-26
Operation	11-26
Packet mode support	11-27
Fault Finding	11-27
Default Setup	11-28
Addressing	11-28
Frame Control Fields	11-29
Non-Associated Signalling	11-30
Q.931	11-32
Service Profile Identifiers (SPIDs)	11-33
Profiles That Require SPIDs	11-33
Definition of SPIDs	11-34
SPID Initialisation	11-34
SPID Debugging	11-35
Automatic ISDN Switch Detection	11-38

Call Control	11-39
Call Logging	11-43
Using a Domain Name Server	11-44
Slotted Interface Numbering	11-44
Always On/Dynamic ISDN (AODI)	11-45
Components of AODI	11-45
Configuring AODI	11-46
Data Over Voice	11-48
Configuration Examples	11-49
A Basic ISDN Setup	11-49
Configuring ISDN Dial on Demand	11-58
Configuring ISDN Bandwidth on Demand	11-58
Refining the ISDN Setup	11-59
Command Reference	11-61
activate isdn call	11-61
activate q931 aspid	11-62
activate q931 message	11-63
add isdn call	11-64
add isdn cilist	11-70
add isdn domainname	11-70
add lapd tei	11-71
add lapd xspid	11-71
add lapd xtei	11-72
deactivate isdn call	11-73
delete isdn call	11-73
delete isdn cilist	11-74
delete isdn domainname	11-74
delete lapd tei	11-75
delete lapd xspid	11-76
delete lapd xtei	11-77
disable bri ctest	11-77
disable bri debug	11-78
disable bri test	11-78
disable isdn call	11-79
disable isdn log	11-80
disable pri ctest	11-80
disable pri debug	11-81
disable pri test	11-81
disable q931 debug	11-82
enable bri ctest	11-84
enable bri debug	11-85
enable bri test	11-86
enable isdn call	11-88
enable isdn log	11-88
enable pri ctest	11-89
enable pri debug	11-90
enable pri test	11-91
enable q931 aspid	11-92
enable q931 debug	11-93
reset bri	11-98
reset bri counter	11-98
reset pri	11-99
reset pri counter	11-100
reset q931	11-101
set bri	11-102
set isdn call	11-104
set isdn domainname	11-110
set isdn log	11-110
set lapd	11-111

set pri	11-113
set q931	11-117
set system territory	11-120
show bri configuration	11-121
show bri counter	11-123
show bri ctest	11-130
show bri debug	11-131
show bri state	11-132
show bri test	11-136
show isdn call	11-139
show isdn clilist	11-143
show isdn domainname	11-144
show isdn log	11-145
show lapd	11-147
show lapd count	11-150
show lapd state	11-151
show pri configuration	11-152
show pri counter	11-153
show pri ctest	11-163
show pri debug	11-164
show pri state	11-165
show pri test	11-171
show q931	11-173
show q931 spid	11-176

CHAPTER 12 Time Division Multiplexing (TDM)

Introduction	12-2
E1/T1 Time Division Multiplexing	12-3
Static E1/T1 TDM Versus ISDN Calling	12-4
BRI Time Division Multiplexing	12-5
Configuration Examples	12-5
Configuring static E1/T1 TDM on a PRI	12-5
Configuring TDM on a BRI	12-7
Command Reference	12-8
add tdm	12-8
create tdm	12-9
delete tdm	12-10
destroy tdm	12-11
purge tdm	12-11
show tdm	12-12

CHAPTER 13 X.25

Introduction	13-3
LAPB	13-4
DCE Mode	13-5
DTE Mode	13-6
DTE Addresses	13-7
X.25 DCE Route Mapping	13-7
Encapsulations	13-8
Configuring LAPB	13-10
Configuring an Interface for LAPB	13-10
Configuring LAPB Interface Parameters	13-10
Configuring X.25 DCE	13-11
Configure an LAPB Interface	13-11
Configure the X.25 DCE Interface	13-11
Configuring DTE Addresses on DCEs	13-12
Configuring X.25 Route Mapping	13-13
Configuring X.25 DCE TCP Keepalive parameters	13-13
Displaying and Debugging X.25 DCE Interfaces	13-13

Configuring X.25 DTE	13-14
Configure an LAPB Interface	13-14
Configure the X.25 DTE Interface	13-14
Configuring Call Parameter Entries	13-15
Configuring Permanent Virtual Circuits	13-15
Hunt Groups	13-16
Configuration Examples	13-18
A Basic X.25 Setup	13-18
An Extended X.25 Setup	13-24
X.25 over ISDN D Channel	13-30
X.25 Hunt Groups	13-31
Command Reference	13-38
activate miox circuit	13-39
activate x25c test	13-40
add miox circuit	13-41
add x25c dteaddress	13-43
add x25c huntgroup	13-44
add x25c route	13-45
add x25t cpar	13-46
create lapb	13-47
create x25c	13-49
create x25c huntgroup	13-51
create x25t	13-52
deactivate miox circuit	13-54
delete miox circuit	13-55
delete x25c dteaddress	13-56
delete x25c huntgroup	13-57
delete x25c route	13-58
delete x25t cpar	13-58
destroy lapb	13-59
destroy x25c	13-59
destroy x25c huntgroup	13-60
destroy x25t	13-60
disable miox circuit	13-61
disable x25c debug	13-61
enable miox circuit	13-62
enable x25c debug	13-62
reset lapb	13-63
reset x25t	13-63
set lapb	13-64
set miox	13-65
set miox circuit	13-66
set x25c	13-68
set x25c huntgroup	13-70
set x25c tcpkeepalive	13-71
set x25t	13-72
set x25t cpar	13-74
show lapb	13-75
show miox	13-80
show miox count	13-81
show miox circuit	13-83
show x25c	13-87
show x25c counter	13-89
show x25c dteaddress	13-92
show x25c huntgroup	13-93
show x25c path	13-94
show x25c route	13-95
show x25c state	13-96
show x25c tcpkeepalive	13-97
show x25t	13-98
show x25t cpar	13-103

CHAPTER 14 **Frame Relay**

Introduction	14-3
Encapsulation	14-4
Data Link Connections	14-6
The Local Management Interface (LMI)	14-7
Logical Interfaces	14-8
Disabling or Resetting a Frame Relay Interface	14-8
Disabling or Resetting a Frame Relay DLC	14-9
Slow-Start Mechanism	14-9
Congestion Detection	14-10
Detection using CLLM messages	14-10
Detection using BECN bits	14-11
Congestion Control Scheme	14-12
Frame Relay on the Router	14-14
Encryption and Compression over Frame Relay	14-15
Troubleshooting Frame Relay Networks	14-15
Configuring Frame Relay	14-16
Configuration Examples	14-19
Frame Relay without an LMI	14-19
Frame Relay with an LMI	14-23
Using Frame Relay Logical Interfaces	14-25
Command Reference	14-26
add framerelay dlc	14-27
add framerelay li	14-28
create framerelay	14-29
delete framerelay dlc	14-32
delete framerelay li	14-32
destroy framerelay	14-33
disable framerelay	14-33
disable framerelay congestioncontrol	14-34
disable framerelay debug	14-34
disable framerelay dlc	14-35
disable framerelay dlc debug	14-36
disable framerelay li debug	14-37
disable framerelay slowstart	14-38
enable framerelay	14-38
enable framerelay congestioncontrol	14-39
enable framerelay debug	14-40
enable framerelay dlc	14-41
enable framerelay dlc debug	14-42
enable framerelay li debug	14-44
enable framerelay slowstart	14-44
reset framerelay	14-45
reset framerelay dlc	14-46
set framerelay	14-47
set framerelay dlc	14-50
show framerelay	14-52
show framerelay dlc	14-62
show framerelay li	14-70

CHAPTER 15 **Point-to-Point Protocol (PPP)**

Introduction	15-3
The Point-to-Point Protocol	15-3
Encapsulation	15-3
Control Protocols	15-5
LCP Options	15-6
Configuring PPP	15-7
Link Quality Management	15-9
Multilink PPP	15-9
Bandwidth Allocation Protocol	15-10
Dial-On-Demand	15-11
Link Backup	15-11
Bandwidth on Demand	15-13
Always On/Dynamic ISDN (AODI)	15-14
Synchronous Dialling	15-15
PPP Over Ethernet	15-16
PPP over Ethernet Client Mode	15-17
PPP over Ethernet Access Concentrator Mode	15-17
Templates	15-18
PPP Callback	15-19
Magic Number	15-21
MSS Clamping	15-21
Overview	15-21
Example	15-22
Authentication Protocols	15-22
Password Authentication Protocol (PAP)	15-23
Challenge-Handshake Authentication Protocol (CHAP)	15-23
Router configuration	15-25
Assigning IP Addresses	15-27
PPP Link Management	15-29
Configuring PPP Control Protocols	15-30
Debugging PPP Links	15-31
Configuration Examples	15-34
Configuring a PPP link	15-34
Multilink Aggregation	15-37
Dial-on-Demand Links	15-39
Link Quality Monitoring	15-39
Compression and Encryption	15-40
Leased Line Backup	15-41
Bandwidth on Demand	15-43
Bandwidth on Demand with Leased Line Circuits and ISDN	15-45
Command Reference	15-48
activate ppp	15-49
add ppp	15-50
add ppp acservice	15-54
create ppp	15-56
create ppp template	15-63
delete ppp	15-70
delete ppp acservice	15-71
destroy ppp	15-72
destroy ppp template	15-72
disable ppp	15-73
disable ppp accessconcentrator	15-73
disable ppp debug	15-74
disable ppp template debug	15-75
enable ppp	15-76
enable ppp accessconcentrator	15-77
enable ppp debug	15-78
enable ppp template debug	15-80

purge ppp	15-81
reset ppp	15-82
set ppp	15-83
set ppp acservice	15-90
set ppp template	15-92
show ppp	15-98
show ppp config	15-99
show ppp count	15-105
show ppp debug	15-118
show ppp idletimer	15-119
show ppp limits	15-120
show ppp multilink	15-121
show ppp nameserver	15-123
show ppp pppoe	15-124
show ppp template	15-126
show ppp txstatus	15-130
show ppp utilisation	15-132

CHAPTER 16 **Bridging**

Introduction	16-3
Bridging on the Router	16-4
Remote Bridging	16-5
Virtual Ports and Switch Ports	16-5
VLAN-to-WAN Bridging	16-7
Internal Representation of the VLAN-to-WAN Bridge	16-7
The VLAN-to-WAN Bridging Process	16-7
LAN-to-LAN Bridging	16-8
WAN-to-WAN Bridging	16-10
Internal Representation of the WAN-to-WAN Bridge	16-11
Bridge Learning and Forwarding	16-11
The Learning Process	16-12
The Forwarding Process	16-13
Filtering	16-14
Telnet to a Router Bridging IP	16-15
Spanning Tree Protocol	16-15
Electing the Root Bridge and Designated Bridge	16-16
Configuration Examples	16-17
A Basic LAN Bridge Setup	16-17
Bridging in a Meshed Network with Spanning Tree	16-19
A Bridge Setup Using Filters	16-21
VLAN-to-WAN Bridge Configuration	16-23
Command Reference	16-25
add bridge filter	16-25
add bridge group	16-28
add bridge port	16-29
add bridge protocol	16-30
add bridge station	16-33
add vlan bridge	16-34
delete bridge filter	16-35
delete bridge group	16-35
delete bridge port	16-36
delete bridge protocol	16-36
delete bridge station	16-37
delete vlan bridge	16-38
disable bridge	16-38
disable bridge learning	16-38
disable bridge spanning	16-39
enable bridge	16-39

enable bridge learning	16-39
enable bridge spanning	16-40
purge bridge	16-40
reset bridge	16-41
set bridge ageingtimer	16-41
set bridge filter	16-42
set bridge group	16-44
set bridge port	16-45
set bridge protocol	16-46
set bridge spanning	16-47
set bridge stripvlantag	16-48
show bridge	16-49
show bridge counter	16-52
show bridge counter	16-55
show bridge filter	16-58
show bridge group	16-61
show bridge port	16-63
show bridge protocol	16-66
show bridge spanning	16-67
show bridge station	16-69
CHAPTER 17 Synchronous Tunnelling	
Introduction	17-2
Synchronous Tunnelling on the Router	17-2
Configuration Example	17-3
Command Reference	17-5
add stt	17-5
delete stt	17-6
reset stt	17-6
set stt	17-7
show stt	17-8
CHAPTER 18 Transaction Packet Assembler Disassembler (TPAD)	
Introduction	18-2
The TPAD Protocol	18-3
TPAD on the Router	18-5
TPAD Chip and PIN Authentication	18-7
The Hayes Standard AT Command Set on the Router	18-8
TPAD Fast Disconnect	18-9
Configuration Examples	18-10
Configuring X.25 Interfaces	18-10
Creating TPAD Instances	18-12
Troubleshooting TPAD	18-14
Command Reference	18-17
add tpad	18-17
create tpad	18-18
delete tpad	18-21
destroy tpad	18-21
disable tpad	18-22
disable tpad debug	18-22
enable tpad	18-23
enable tpad debug	18-23
reset tpad	18-24
set tpad	18-25
show tpad	18-28
show tpad connections	18-31
show tpad counter	18-33

CHAPTER 19 **Asynchronous Call Control**

Introduction	19-2
Call Definitions	19-2
Authenticating Incoming Calls	19-5
RADIUS Authentication	19-5
RADIUS Accounting	19-6
Using Modem Scripts	19-6
Bidirectional Calls	19-8
Interface with Higher Layers	19-9
Using a Domain Name Server	19-10
Configuration Examples	19-10
Defining an ACC Call	19-10
Assigning IP Addresses	19-12
Dial-in IPX	19-13
Router-to-Router PPP	19-13
Command Reference	19-16
activate acc call	19-16
add acc call	19-17
add acc domainname	19-20
add acc script	19-21
deactivate acc call	19-22
delete acc call	19-23
delete acc domainname	19-23
delete acc script	19-24
disable acc call	19-24
disable acc call debug	19-25
enable acc call	19-25
enable acc call debug	19-26
purge acc	19-26
purge acc script	19-27
set acc call	19-28
set acc call asyn	19-31
set acc script	19-32
show acc	19-34
show acc call	19-35
show acc domainname	19-38
show acc script	19-38

CHAPTER 20 **Layer Two Tunnelling Protocol (L2TP)**

Introduction	20-3
Overview of L2TP	20-3
Overview of L2TP on the Router	20-5
Enabling L2TP on the Router	20-6
Accepting Incoming Calls as an LAC	20-6
Accepting L2TP Sessions as an LNS	20-7
Creating a Call from an LNS to an LAC	20-8
Monitoring L2TP Connections	20-10
Debugging L2TP Connections	20-10
Reflecting TOS onto L2TP-Tunnelled Packets	20-11
Configuration Examples	20-12
Inter-Router Tunnels	20-12
Simple Dial-In System	20-14
Configure L2TP to Tunnel PPPoE Sessions	20-16
Command Reference	20-18
activate l2tp call	20-18
add l2tp call	20-19
add l2tp ip	20-22
add l2tp password	20-24
add l2tp user	20-25
deactivate l2tp call	20-28

delete l2tp call	20-28
delete l2tp ip	20-29
delete l2tp password	20-30
delete l2tp user	20-31
disable l2tp	20-32
disable l2tp debug	20-33
disable l2tp server	20-34
enable l2tp	20-34
enable l2tp debug	20-35
enable l2tp server	20-39
reset l2tp counter	20-39
set l2tp call	20-40
set l2tp checksum	20-43
set l2tp filter	20-43
set l2tp password	20-44
set l2tp user	20-45
show l2tp	20-48
show l2tp call	20-50
show l2tp counter	20-52
show l2tp ip	20-55
show l2tp tunnel	20-56
show l2tp tunnel call	20-59
show l2tp tunnel call counter	20-63
show l2tp tunnel counter	20-65
show l2tp user	20-67
CHAPTER 21 Overview of Routing	
Introduction	21-2
IP Networks	21-2
Configuration Example	21-2
OSPF	21-5
Routing Information Protocol (RIP)	21-6
IP Multicasting	21-6
Configuring IGMP	21-7
Configuring Multicast Routing	21-7
Novell IPX	21-8
AppleTalk	21-10
CHAPTER 22 Internet Protocol (IP)	
Introduction	22-5
IP Packets	22-5
Addressing	22-7
Subnets	22-9
Assigning an IP Address	22-10
Multihoming	22-11
Local Interfaces	22-11
Address Resolution Protocol (ARP)	22-13
Static ARP Entries	22-13
Adding Static ARP Entries with Multicast MAC Addresses	22-14
Timing Out ARP Entries	22-15
Deleting ARP Entries	22-16
Proxy ARP	22-17
MAC Address Logging	22-18
Waiting for a Response to an ARP Request	22-18
DHCP Client	22-19
ICMP	22-19
Routing	22-20
Types of Routes	22-20
The Routing Table	22-21
Configuring Static Routes	22-21

Caching Routes	22-22
Dynamic Routing Protocols	22-22
Setting Preference of Dynamically-Learned Routes	22-23
Displaying Route Information	22-23
Equal Cost Multipath Routing	22-24
Routing Information Protocol (RIP)	22-24
Open Shortest Path First (OSPF)	22-25
Border Gateway Protocol (BGP)	22-25
Metrics	22-25
OSPF Auto Cost Calculation	22-25
Policy-Based Routing	22-26
Priority-Based Routing	22-27
Route Templates	22-28
VLAN Tagging on Eth Interfaces	22-29
Domain Name System (DNS)	22-30
Usage of Domain Name Servers	22-30
Configuring Domain Name Servers	22-32
DNS Caching	22-34
Dynamic DNS Client	22-35
Named Hosts	22-35
Traffic Filters	22-36
SNMP	22-38
Control and Debug Commands	22-39
Ping and Trace Route	22-40
Ping	22-40
Trace Route	22-40
Finger	22-41
Security Options	22-43
Security Associations	22-43
Broadcast Forwarding	22-44
IP Multicasting	22-47
Static Multicast Forwarding	22-48
Network Address Translation (NAT)	22-48
PPTP Pass Through	22-51
Remote Address Assignment	22-51
IP Address Pools	22-52
Configuration Examples	22-54
Basic IP Setup over PPP	22-54
Configuring IP Filters	22-57
Troubleshooting	22-62
No Route Exists to the Remote Router	22-62
Getting an IP Address from DHCP	22-63
Telnet Fails	22-64
Command Reference	22-65
activate ddns update	22-65
add ip arp	22-66
add ip dns	22-68
add ip filter	22-70
add ip helper	22-78
add ip host	22-79
add ip interface	22-80
add ip local	22-86
add ip nat	22-87
add ip route	22-90
add ip route template	22-93
add ip sa	22-95
create ip pool	22-96
delete ip arp	22-96
delete ip dns	22-97
delete ip filter	22-98
delete ip helper	22-99

delete ip host	22-100
delete ip interface	22-101
delete ip local	22-102
delete ip nat	22-103
delete ip route	22-105
delete ip route template	22-106
delete ip sa	22-107
delete tcp	22-108
destroy ip pool	22-108
disable ddns	22-108
disable ddns debug	22-109
disable ip	22-109
disable ip arp agepoll	22-110
disable ip arp log	22-110
disable ip debug	22-110
disable ip dnsrelay	22-111
disable ip echoreply	22-111
disable ip fofilter	22-112
disable ip forwarding	22-113
disable ip helper	22-113
disable ip icmpreply	22-114
disable ip interface	22-115
disable ip macdisparity	22-116
disable ip nat	22-117
disable ip remoteassign	22-118
disable ip route	22-118
disable ip spoofcheck	22-119
disable ip srcroute	22-119
disable tcp debug	22-120
disable telnet server	22-120
enable ddns	22-121
enable ddns debug	22-121
enable ip	22-122
enable ip arp agepoll	22-122
enable ip arp log	22-122
enable ip debug	22-123
enable ip dnsrelay	22-124
enable ip echoreply	22-124
enable ip fofilter	22-125
enable ip forwarding	22-126
enable ip helper	22-126
enable ip icmpreply	22-127
enable ip interface	22-128
enable ip macdisparity	22-129
enable ip nat	22-130
enable ip remoteassign	22-131
enable ip route	22-131
enable ip spoofcheck	22-132
enable ip srcroute	22-132
enable tcp debug	22-133
enable telnet server	22-133
finger	22-134
ping	22-135
purge ip	22-137
reset ip	22-138
reset ip counter	22-138
reset ip interface	22-139
set ddns	22-140
set ip arp	22-142
set ip arp refresharp	22-143
set ip arp timeout	22-144

set ip arpwaittimeout	22-145
set ip dns	22-146
set ip dns cache	22-148
set ip dnsrelay	22-149
set ip filter	22-150
set ip host	22-154
set ip interface	22-155
set ip local	22-160
set ip nameserver	22-162
set ip nat maxfragments	22-163
set ip route	22-164
set ip route preference	22-166
set ip route template	22-168
set ip secondarynameserver	22-170
set ping	22-171
set trace	22-174
show ddns	22-176
show ip	22-178
show ip arp	22-181
show ip cache	22-182
show ip counter	22-183
show ip debug	22-192
show ip dns	22-193
show ip dns cache	22-195
show ip filter	22-196
show ip helper	22-198
show ip host	22-200
show ip icmpreply	22-201
show ip interface	22-202
show ip nat	22-206
show ip pool	22-211
show ip route	22-213
show ip route multicast	22-217
show ip route preference	22-218
show ip route template	22-219
show ip sa	22-221
show ip udp	22-222
show ping	22-224
show tcp	22-226
show trace	22-231
stop ping	22-233
stop trace	22-233
trace	22-234

CHAPTER 23 **Dynamic Host Configuration Protocol (DHCP)**

Introduction	23-2
Configuring the DHCP Server	23-3
BOOTP Relay Agent	23-4
DHCP Option 82 Relay	23-6
Configuring the DHCP Client	23-6
DHC Files	23-6
Configuration Example	23-7
Troubleshooting	23-8
Command Reference	23-9
add bootp relay	23-10
add dhcp option	23-11
add dhcp policy	23-13
add dhcp range	23-19

create dhcp policy	23-20
create dhcp range	23-21
delete bootp relay	23-22
delete dhcp option	23-23
delete dhcp policy	23-24
delete dhcp range	23-28
destroy dhcp policy	23-29
destroy dhcp range	23-29
disable bootp relay	23-30
disable bootp relay option82	23-30
disable dhcp	23-31
disable dhcp debug	23-32
enable bootp relay	23-32
enable bootp relay option82	23-33
enable dhcp	23-33
enable dhcp debug	23-34
purge bootp relay	23-34
set bootp relay maxhops	23-35
set bootp relay option82	23-36
set bootp relay option82 port	23-37
set dhcp	23-38
set dhcp option	23-39
set dhcp policy	23-41
set dhcp range	23-47
show bootp relay	23-48
show bootp relay port	23-50
show dhcp	23-51
show dhcp client	23-53
show dhcp policy	23-55
show dhcp range	23-57

CHAPTER 24 IP Multicasting

Introduction	24-3
References	24-3
IP Multicast Routing	24-4
Interoperability between Multicast Routing Protocols	24-5
Distance Vector Multicast Routing Protocol (DVMRP)	24-5
Configuring DVMRP	24-6
Protocol Independent Multicast (PIM)	24-8
PIM Dense Mode	24-8
PIM Sparse Mode	24-10
Internet Group Management Protocol (IGMP)	24-18
Configuring IGMP	24-19
IGMP Proxy	24-20
IGMP Snooping	24-22
IGMP Filtering	24-25
IGMP Throttling	24-27
Configuration Examples	24-29
Multicasting using DVMRP	24-29
Protocol Independent Multicast (PIM)	24-35
Command Reference	24-42
add dvmrp interface	24-43
add igmp filter	24-44
add igmpsnooping routeraddress	24-45
add igmpsnooping vlan	24-46
add pim bsr candidate	24-47
add pim interface	24-48
add pim rpcandidate	24-50

create igmp filter	24-52
delete dvmrp interface	24-53
delete igmp filter	24-54
delete igmpsnooping routeraddress	24-54
delete igmpsnooping vlan	24-55
delete pim bsrcandidate	24-55
delete pim interface	24-56
delete pim rpcandidate	24-57
destroy igmp filter	24-58
disable dvmrp	24-58
disable dvmrp debug	24-59
disable igmpsnooping	24-60
disable ip igmp	24-60
disable ip igmp allgroup	24-61
disable ip igmp debug	24-61
disable ip igmp interface	24-62
disable pim	24-62
disable pim bsmsecuritycheck	24-63
disable pim debug	24-63
enable dvmrp	24-64
enable dvmrp debug	24-65
enable igmpsnooping	24-66
enable ip igmp	24-66
enable ip igmp allgroup	24-67
enable ip igmp debug	24-67
enable ip igmp interface	24-68
enable pim	24-68
enable pim bsmsecuritycheck	24-69
enable pim debug	24-69
purge dvmrp	24-70
purge pim	24-70
reset dvmrp interface	24-71
reset pim interface	24-72
set dvmrp interface	24-73
set igmp filter	24-74
set igmpsnooping vlan	24-75
set igmpsnooping routermode	24-76
set ip igmp	24-77
set ip igmp interface	24-78
set pim	24-79
set pim log	24-80
set pim bsrcandidate	24-81
set pim interface	24-82
set pim rpcandidate	24-84
show dvmrp	24-85
show dvmrp counters	24-86
show dvmrp debug	24-87
show dvmrp forwarding	24-88
show dvmrp interface	24-89
show dvmrp neighbour	24-90
show dvmrp route	24-91
show igmp filter	24-92
show igmpsnooping	24-94
show igmpsnooping counter	24-96
show igmpsnooping routeraddress	24-98
show ip igmp	24-99
show ip igmp counter	24-102
show ip igmp debug	24-104
show pim	24-105

show pim bsrcandidate	24-106
show pim config	24-107
show pim counters	24-108
show pim debug	24-111
show pim interface	24-112
show pim neighbour	24-114
show pim route	24-115
show pim rpcandidate	24-121
show pim rpsset	24-122
show pim staterefresh	24-124
show pim timer	24-125

CHAPTER 25 Routing Information Protocol (RIP)

Introduction	25-2
Configuring RIP	25-3
Redistributing Routes into RIP	25-4
Statically-Configured Routes	25-4
BGP Routes	25-4
Configuration Example	25-5
Command Reference	25-7
add ip rip interface	25-7
add ip rip redistribute	25-10
add ip trusted	25-11
delete ip rip interface	25-12
delete ip rip redistribute	25-13
delete ip trusted	25-13
set ip rip interface	25-14
set ip rip redistribute	25-17
set ip riptimer	25-18
show ip rip	25-19
show ip rip counter	25-21
show ip rip redistribute	25-23
show ip riptimer	25-24
show ip trusted	25-25

CHAPTER 26 Open Shortest Path First (OSPF)

Introduction	26-3
OSPF Features	26-3
Adjacency and Designated Routers	26-5
Link State Advertisements	26-5
OSPF Packet Types	26-6
OSPF States	26-7
Automatic Cost Calculation	26-8
Routing with OSPF	26-9
Filtering OSPF Routes	26-9
Addressless Interfaces	26-10
Network Types	26-10
Passive Interfaces	26-12
Authenticating OSPF	26-13
Password Authentication	26-13
Cryptographic Authentication	26-13
Exchanging Information Between OSPF and RIP	26-14
Importing BGP routes into OSPF	26-15
Redistributing External Routes	26-15
Summarising Routes for Redistribution	26-17
OSPF On-Demand Circuits	26-18
Configuration Examples	26-20
Basic OSPF Network	26-20
OSPF Network with Addressless PPP Links	26-22
OSPF Network with Virtual Links	26-24

Command Reference	26-27
add ospf area	26-28
add ospf host	26-30
add ospf interface	26-31
add ospf md5key	26-35
add ospf neighbour	26-36
add ospf range	26-37
add ospf redistribute	26-38
add ospf stub	26-40
add ospf summaryaddress	26-41
delete ospf area	26-42
delete ospf host	26-42
delete ospf interface	26-43
delete ospf md5key	26-44
delete ospf neighbour	26-45
delete ospf range	26-45
delete ospf redistribute	26-46
delete ospf stub	26-47
delete ospf summaryaddress	26-48
disable ospf	26-48
disable ospf debug	26-49
disable ospf interface	26-50
disable ospf log	26-50
enable ospf	26-51
enable ospf debug	26-51
enable ospf interface	26-53
enable ospf log	26-54
purge ospf	26-55
reset ospf	26-55
reset ospf counter	26-56
reset ospf interface	26-57
reset ospf spf	26-58
set ospf	26-59
set ospf area	26-63
set ospf host	26-65
set ospf interface	26-66
set ospf neighbour	26-70
set ospf range	26-71
set ospf redistribute	26-72
set ospf stub	26-74
set ospf summaryaddress	26-75
show ospf	26-76
show ospf area	26-79
show ospf debug	26-82
show ospf host	26-83
show ospf interface	26-85
show ospf lsa	26-90
show ospf md5key	26-95
show ospf neighbour	26-96
show ospf range	26-98
show ospf redistribute	26-100
show ospf route	26-101
show ospf stub	26-103
show ospf summaryaddress	26-104

CHAPTER 27 **Border Gateway Protocol version 4 (BGP-4)**

Introduction	27-3
Overview of BGP-4	27-3
BGP Operation	27-5
BGP Attributes	27-6
BGP Route Selection	27-8
Classless Inter-domain Routing (CIDR) and Aggregation	27-10
BGP Multi-Homing	27-11
BGP Route Filtering	27-13
AS Confederations	27-13
Triggers	27-14
Redistributing BGP Routes	27-15
Configuring BGP Peers	27-16
How to Create a Basic BGP AS	27-16
How to Create BGP Peers Using Peer Templates	27-20
How to Modify BGP Peers (Without Templates)	27-21
How to Use a Template to Modify BGP Peers	27-22
How to Modify BGP Peers that Use a Template	27-23
How to Delete BGP Peers	27-23
Optimising BGP	27-24
How to Minimise the Impact of Unstable EBGp Routes	27-24
How to Withdraw Routes As Soon As they Fail	27-29
How to Advertise as Few Routes as Possible	27-30
How to Improve IBGP Scalability	27-33
How to Handle Spikes in Memory Use	27-38
How to Stop BGP from Overloading System Memory	27-39
How to Avoid Leaking Private AS Numbers into Global BGP Tables	27-40
How to Set the IP Address that Identifies the Router	27-40
Configuration Examples	27-42
Basic BGP Configuration	27-42
Advanced BGP Configuration	27-44
Command Reference	27-47
add bgp aggregate	27-47
add bgp confederationpeer	27-49
add bgp import	27-50
add bgp network	27-51
add bgp peer	27-52
add bgp peertemplate	27-60
create bgp damping parameterset	27-65
delete bgp aggregate	27-67
delete bgp confederationpeer	27-68
delete bgp import	27-68
delete bgp network	27-69
delete bgp peer	27-69
delete bgp peertemplate	27-70
destroy bgp damping parameterset	27-70
disable bgp autosoftupdate	27-71
disable bgp autosummary	27-71
disable bgp backoff	27-72
disable bgp damping	27-73
disable bgp debug	27-74
disable bgp defaultoriginate	27-75
disable bgp peer	27-75
enable bgp autosoftupdate	27-76
enable bgp autosummary	27-76
enable bgp backoff	27-77
enable bgp damping	27-78
enable bgp debug	27-79
enable bgp defaultoriginate	27-80
enable bgp peer	27-81
purge bgp damping	27-81

reset bgp damping	27-82
reset bgp peer	27-82
reset bgp peer soft	27-83
set bgp	27-84
set bgp aggregate	27-87
set bgp backoff	27-88
set bgp damping parameterset	27-89
set bgp import	27-91
set bgp memlimit	27-92
set bgp peer	27-93
set bgp peertemplate	27-101
set ip autonomous	27-106
show bgp	27-107
show bgp aggregate	27-109
show bgp confederation	27-110
show bgp backoff	27-111
show bgp counters	27-113
show bgp damping	27-117
show bgp damping routes	27-119
show bgp import	27-120
show bgp memlimit	27-121
show bgp memlimit scan	27-122
show bgp network	27-124
show bgp peer	27-125
show bgp peertemplate	27-130
show bgp route	27-132

CHAPTER 28 **Filtering IP Routes**

Introduction	28-3
Types of Filters	28-4
About Prefix Lists	28-4
About AS Path Lists	28-5
About Route Maps	28-5
About IP Route Filters	28-7
About IP Filters	28-8
Creating Filters	28-9
Creating Prefix Lists	28-9
Creating AS Path Lists for BGP Routes	28-9
Creating Route Maps for BGP Routes	28-10
Creating Route Maps for OSPF Routes	28-16
Creating Route Maps for Redistributing BGP Routes into RIP	28-20
Creating IP Route Filters	28-21
Creating IP Filters	28-22
Applying Filters	28-22
Applying Filters When Writing to the RIB	28-22
Applying Filters When Redistributing from the RIB	28-24
Applying Filters Before Advertising Routes	28-28
Overview of Filters for each Route Source	28-30
Border Gateway Protocol (BGP-4)	28-30
Open Shortest Path First (OSPF)	28-31
Routing Information Protocol (RIP)	28-33
Interface Routes	28-34
Statically-Configured Routes	28-34
Configuration Examples	28-35
Filtering When Writing BGP Routes to the RIB: Using an AS Path Filter ..	28-35
Filtering When Writing BGP Routes to the RIB: Using a Route Map	28-36
Filtering Before Advertising Routes with BGP: Using an AS Path Filter ..	28-37
Filtering Before Advertising Routes with BGP: Using a Route Map	28-38
Filtering Inbound and Outbound BGP Routes: Using Communities	28-39
Filtering When Importing Routes from BGP to OSPF	28-40

Command Reference	28-41
add ip aspathlist	28-41
add ip communitylist	28-43
add ip prefixlist	28-45
add ip route filter	28-47
add ip routemap	28-50
delete ip aspathlist	28-57
delete ip communitylist	28-58
delete ip prefixlist	28-58
delete ip route filter	28-59
delete ip routemap	28-60
set ip prefixlist	28-61
set ip route filter	28-63
set ip routemap	28-65
show ip aspathlist	28-72
show ip communitylist	28-73
show ip prefixlist	28-74
show ip route filter	28-76
show ip routemap	28-77
CHAPTER 29 Voice over IP (VoIP)	
Introduction	29-3
VoIP Overview	29-3
VoIP Benefits and Business Applications	29-5
VoIP FXS Interface Components	29-6
Ring Generation	29-6
Tone Generation	29-6
Port Gain	29-6
Port Impedance	29-6
Voice Activation and Silence Detection	29-7
Digit Collection	29-7
VoIP Protocols	29-7
H.323	29-7
Session Initiation Protocol (SIP)	29-12
VoIP Engines	29-17
Loading VoIP Firmware onto a PIC	29-18
Configuration Examples	29-20
Using H.323 and no gatekeeper	29-20
Using H.323 and a gatekeeper	29-22
Using a SIP server	29-23
Command Reference	29-25
create h323	29-25
create h323 entry	29-27
create sip	29-28
destroy h323	29-30
destroy h323 entry	29-31
destroy sip	29-32
disable voip	29-32
disable voip debug	29-33
enable voip	29-33
enable voip debug	29-34
reset voip	29-35
set h323	29-36
set h323 entry	29-37
set h323 gateway	29-38
set sip	29-39
set sip gateway	29-41
set voip	29-42
set voip ap	29-43
set voip bootcode	29-45

set voip file	29-45
set voip phone	29-46
set voip public interface	29-53
show h323	29-54
show h323 entry	29-55
show h323 gateway	29-56
show sip	29-57
show sip gateway	29-58
show voip	29-59
show voip ap	29-61
show voip counter engine	29-63
show voip instance	29-65
show voip load	29-66
show voip phone	29-67

CHAPTER 30 **Generic Routing Encapsulation (GRE)**

Introduction	30-2
GRE on the Router	30-3
Configuration Examples	30-5
Basic Configuration	30-5
Multi-Point Configuration	30-7
Command Reference	30-11
add gre	30-12
add gre tunnel	30-14
delete gre	30-15
delete gre tunnel	30-15
disable gre	30-16
disable gre debug	30-16
enable gre	30-16
enable gre debug	30-17
purge gre	30-17
reset gre	30-18
set gre	30-19
set gre tunnel	30-21
show gre	30-22
show gre general	30-23
show gre tunnel	30-24

CHAPTER 31 **Internet Protocol version 6 (IPv6)**

Introduction	31-3
Overview of IPv6	31-3
The 6bone	31-4
IPv6 Addresses and Prefixes	31-4
IPv6 Headers	31-6
The Internet Control Message Protocol (ICMPv6)	31-8
IPv6 Routing	31-11
IPv6 Filtering	31-12
Integration of IPv4 and IPv6	31-12
IPv6 on the Router	31-13
Enabling IPv6	31-13
IPv6 Interfaces and Addresses	31-14
Extension Header Processing	31-15
Routing Table Processing and RIPv6	31-16
Neighbour Discovery	31-17
IPv6 Filtering	31-18
IPv6 Fragmentation	31-19
Telnet v6	31-19
Ping	31-20
Secure Shell	31-20

Tunnelling IPv6 Packets over IPv4	31-21
Configuration Examples	31-23
Basic Routing	31-23
Dynamic Routing with RIPv6	31-25
Dynamic (6-to-4) Tunnelling over an IPv4 Network	31-29
Static Tunnelling over an IPv4 Network	31-32
IPv6 Filters	31-34
Command Reference	31-36
add ipv6 6to4	31-36
add ipv6 filter	31-37
add ipv6 host	31-42
add ipv6 interface	31-43
add ipv6 nd	31-46
add ipv6 prefix	31-47
add ipv6 rip	31-48
add ipv6 route	31-49
add ipv6 tunnel	31-51
create ipv6 interface	31-52
delete ipv6 6to4	31-53
delete ipv6 filter	31-53
delete ipv6 host	31-54
delete ipv6 interface	31-54
delete ipv6 nd	31-55
delete ipv6 prefix	31-56
delete ipv6 rip	31-57
delete ipv6 route	31-58
delete ipv6 tunnel	31-59
destroy ipv6 interface	31-60
disable ipv6	31-60
disable ipv6 advertise	31-61
disable ipv6 debug	31-61
disable ipv6 mtudiscovery	31-62
disable ipv6 rip	31-62
enable ipv6	31-62
enable ipv6 advertise	31-63
enable ipv6 debug	31-64
enable ipv6 mtudiscovery	31-64
enable ipv6 rip	31-64
reset ipv6 ndcache	31-65
set ipv6 filter	31-66
set ipv6 interface	31-69
set ipv6 mtu	31-70
set ipv6 nd	31-71
set ipv6 prefix	31-73
set ipv6 route preference	31-74
show ipv6	31-75
show ipv6 counter	31-77
show ipv6 filter	31-81
show ipv6 host	31-83
show ipv6 interface	31-84
show ipv6 multicast	31-86
show ipv6 ndcache	31-87
show ipv6 ndconfig	31-88
show ipv6 rip	31-90
show ipv6 route	31-92
show ipv6 route multicast	31-93
show ipv6 route preference	31-94
show ipv6 tunnel	31-95
show ipv6 udp	31-96

CHAPTER 32 **Dynamic Host Configuration Protocol for IPv6 (DHCP6)**

Introduction	32-2
DHCP for IPv6	32-2
DHCP6 Messages	32-3
DHCP Unique Identifier (DUID)	32-3
Identity Associations	32-3
Configuring DHCP6 Servers	32-4
Configuring DHCP6 Clients	32-5
DHCP6 Message Authentication	32-6
Rapid Commit	32-6
Configuration Examples	32-7
Address Assignment	32-7
Prefix Delegation	32-8
Command Reference	32-10
add dhcp6 interface	32-10
add dhcp6 key	32-11
add dhcp6 policy	32-12
add dhcp6 range	32-14
create dhcp6 policy	32-15
create dhcp6 range	32-16
delete dhcp6 interface	32-17
delete dhcp6 key	32-17
delete dhcp6 policy	32-18
delete dhcp6 range	32-19
destroy dhcp6 policy	32-19
destroy dhcp6 range	32-20
disable dhcp6	32-20
disable dhcp6 debug	32-20
disable dhcp6 rapidcommit	32-21
enable dhcp6	32-21
enable dhcp6 debug	32-21
enable dhcp6 rapidcommit	32-22
set dhcp6 key	32-23
set dhcp6 policy	32-24
show dhcp6	32-26
show dhcp6 client	32-28
show dhcp6 counter	32-30
show dhcp6 interface	32-33
show dhcp6 key	32-35
show dhcp6 policy	32-36
show dhcp6 range	32-37
show dhcp6 server	32-38

CHAPTER 33 **IPv6 Multicasting**

Introduction	33-3
Overview of IPv6 Multicast Routing	33-3
Interoperability between Multicast Routing Protocols	33-4
Multicast Listener Discovery (MLD)	33-5
Queries and Reports	33-5
Configuring MLD	33-7
Protocol Independent Multicast Sparse Mode (PIM-SM)	33-7
Configuring PIM Sparse Mode	33-7
Protocol Independent Multicast Dense Mode (PIM-DM)	33-11
Configuring PIM Dense Mode	33-11
Configuration Examples	33-13
Command Reference	33-23
add pim6 bsrcandidate	33-23
add pim6 interface	33-24

add pim6 rpcandidate	33-25
delete pim6 bsrcandidate	33-26
delete pim6 interface	33-26
delete pim6 rpcandidate	33-27
disable ipv6 mld	33-27
disable ipv6 mld debug	33-28
disable ipv6 mld interface	33-28
disable pim6	33-29
disable pim6 debug	33-29
enable ipv6 mld	33-30
enable ipv6 mld debug	33-30
enable ipv6 mld interface	33-31
enable pim6	33-32
enable pim6 debug	33-32
purge pim6	33-33
reset pim6 interface	33-33
set ipv6 mld	33-34
set ipv6 mld interface	33-35
set pim6	33-36
set pim6 bsrcandidate	33-37
set pim6 interface	33-38
set pim6 rpcandidate	33-39
show ipv6 mld	33-40
show ipv6 mld config	33-42
show ipv6 mld counters	33-43
show ipv6 mld debug	33-44
show pim6	33-45
show pim6 bsrcandidate	33-46
show pim6 config	33-47
show pim6 counters	33-48
show pim6 debug	33-51
show pim6 interface	33-52
show pim6 neighbour	33-54
show pim6 route	33-55
show pim6 rpcandidate	33-60
show pim6 rpset	33-61
show pim6 staterefresh	33-63
show pim6 timer	33-64

CHAPTER 34 **Open Systems Interconnection (OSI)**

Introduction	34-2
ISO NSAP (Network Service Access Point) Addresses	34-2
ISO on the Router	34-4
Mandatory CLNS Standards	34-4
Optional Sections of CLNS Standards	34-5
Mandatory ESIS Standards	34-6
Optional Sections of ESIS Standards	34-6
Mandatory ISIS Standards	34-6
Optional Sections of ISIS Standards	34-7
Layer 2 protocols supporting CLNS	34-7
CLNS circuits over dial-up PPP interfaces	34-7
SNMP	34-7
Configuration Examples	34-8
Two Routers and One OSI Area	34-8
Three Virtual Routers and Three OSI Areas	34-10
Command Reference	34-12
add clns adjacency	34-12
add clns area	34-13

add clns circuit	34-14
add clns ra	34-16
delete clns adjacency	34-17
delete clns area	34-18
delete clns circuit	34-18
delete clns ra	34-19
disable clns circuit	34-20
disable clns debug	34-20
enable clns	34-21
enable clns circuit	34-22
enable clns debug	34-23
purge clns	34-24
reset clns	34-24
set clns	34-25
set clns circuit	34-27
set clns ra	34-29
show clns	34-30
show clns adjacency	34-31
show clns area	34-33
show clns circuit	34-34
show clns circuit counters	34-37
show clns counters	34-39
show clns detail	34-41
show clns ra	34-44
show clns route	34-45

CHAPTER 35 **AppleTalk**

Introduction	35-3
AppleTalk Protocol Architecture	35-3
AppleTalk Nodes and Networks	35-4
LocalTalk	35-4
EtherTalk and TokenTalk	35-5
AppleTalk Address Resolution Protocol (AARP)	35-6
Address Translation	35-6
Dynamic Assignment of Protocol Addresses	35-6
Datagram Delivery Protocol	35-7
Routing Table Maintenance Protocol (RTMP)	35-8
Name Binding Protocol (NBP)	35-9
Zone Information Protocol (ZIP)	35-10
AppleTalk on the Router	35-11
AppleTalk Filtering	35-12
DDP packet filtering	35-13
RTMP or Routing Update filtering	35-14
Zone Filtering	35-15
AppleTalk Dial-On-Demand	35-16
Extended Ping for AppleTalk	35-17
Configuration Example	35-17
Command Reference	35-22
add apple circuit	35-22
add apple dlci	35-23
add apple packetfilter	35-24
add apple port	35-26
add apple route	35-28
add apple routefilter	35-29
add apple zone	35-30
add apple zonefilter	35-31
delete apple circuit	35-32
delete apple dlci	35-33

delete apple packetfilter	35-34
delete apple port	35-34
delete apple route	35-35
delete apple routefilter	35-35
delete apple zone	35-36
delete apple zonefilter	35-37
disable apple	35-37
disable apple debug	35-38
enable apple	35-38
enable apple debug	35-38
purge apple	35-39
reset apple	35-39
set apple packetfilter	35-40
set apple port	35-42
set apple routeconvert	35-44
set apple routefilter	35-45
set apple zone	35-46
set apple zonefilter	35-47
show apple	35-48
show apple aarp	35-49
show apple circuit	35-50
show apple counter	35-51
show apple dlci	35-57
show apple packetfilter	35-58
show apple port	35-60
show apple route	35-62
show apple routefilter	35-63
show apple zone	35-64
show apple zonefilter	35-65

CHAPTER 36 **Novell IPX**

Introduction	36-3
The IPX Protocol	36-3
Addressing in a Novell Network	36-4
Interfaces and Circuits	36-5
Routing	36-5
Service Advertisement	36-7
Traffic Filters	36-8
RIP and SAP Filters	36-9
Wildcard Expressions	36-9
RIP Filters	36-10
SAP Filters	36-11
Global Versus Circuit-Specific Filters	36-11
Dial-on-Demand IPX	36-12
SPX Spoofing with Dial-on-Demand IPX	36-13
Troubleshooting SPX Spoofing	36-14
Extended PING for IPX	36-15
Counters and the MIB	36-16
Configuration Examples	36-17
Basic IPX Setup	36-17
IPX Dial-On-Demand	36-23
Command Reference	36-31
add ipx circuit	36-31
add ipx exclusion	36-35
add ipx inclusion	36-36
add ipx rip	36-37
add ipx route	36-38
add ipx sap	36-39

add ipx service	36-40
delete ipx circuit	36-42
delete ipx exclusion	36-43
delete ipx inclusion	36-44
delete ipx rip	36-45
delete ipx route	36-45
delete ipx sap	36-46
delete ipx service	36-47
disable ipx	36-47
disable ipx circuit	36-48
enable ipx	36-48
enable ipx circuit	36-49
purge ipx	36-49
reset ipx	36-50
set ipx circuit	36-51
set ipx grip gsap	36-54
set ipx rip	36-55
set ipx sap	36-56
show ipx	36-57
show ipx cache	36-59
show ipx calllog	36-60
show ipx circuit	36-63
show ipx counter	36-65
show ipx exclusion	36-69
show ipx inclusion	36-70
show ipx rip	36-71
show ipx route	36-72
show ipx sap	36-73
show ipx service	36-75
show ipx spxspoof	36-76

CHAPTER 37 **DECnet**

Introduction	37-2
Overview of a DECnet Network	37-2
DECnet Addresses	37-3
Routing and the Default Router	37-4
Routes and Routing Tables	37-5
Filters	37-5
Managing the Router	37-6
Counters	37-6
Timers	37-6
Costs	37-6
Configuration Examples	37-9
A Basic DECnet Setup	37-9
Troubleshooting	37-11
Refining the DECnet Setup	37-12
Command Reference	37-13
add decnet exclusion	37-14
add decnet inclusion	37-15
add decnet interface	37-16
add decnet lpn	37-17
delete decnet exclusion	37-18
delete decnet inclusion	37-19
delete decnet interface	37-20
delete decnet lpn	37-21
disable decnet	37-21
enable decnet	37-22
purge decnet	37-22

	reset decnet	37-23
	set decnet	37-24
	set decnet interface	37-27
	show decnet	37-28
	show decnet counter	37-29
	show decnet exclusion	37-31
	show decnet inclusion	37-32
	show decnet interface	37-33
	show decnet lpn	37-34
	show decnet route	37-35
CHAPTER 38	Generic Packet Classifier	
	Introduction	38-2
	Configuration of Classifiers	38-2
	Command Reference	38-3
	create classifier	38-4
	destroy classifier	38-15
	set classifier	38-16
	show classifier	38-24
CHAPTER 39	Software Quality of Service (QoS)	
	Introducing QoS	39-4
	Stages	39-4
	Interfaces for Software QoS	39-5
	When to Use Software QoS	39-5
	Separate Traffic—Separate Needs	39-6
	Applying QoS in a Network	39-6
	Local Level	39-6
	Domain Level: DiffServ, TOS and 802.1p Priority	39-6
	The Hierarchy	39-9
	Traffic Class Trees	39-10
	Traffic Classes	39-12
	Policies	39-13
	Order of Classifier Matching	39-13
	Dynamic Application Recognition for Voice and Video	39-14
	Processing Points	39-15
	Ingress QoS	39-17
	Egress QoS	39-17
	Tunnel QoS	39-17
	Software QoS Stages	39-18
	Packet Flow	39-18
	Classification: Identifying and Sorting Traffic	39-20
	Bandwidth Class	39-20
	Premarking: Labelling Packets Before Metering	39-20
	Metering: Bandwidth Conformance	39-21
	Packet Queuing	39-24
	RED Curves	39-24
	Dequeuing	39-26
	Queue Scheduling	39-29
	Re-Marking	39-31
	Virtual Bandwidth	39-31
	Configuring a Software QoS Hierarchy	39-32
	The Total Software QoS Solution	39-32
	Default Traffic Class	39-35
	Configuring QoS Stages	39-36
	Premarking	39-36
	Metering	39-37
	RED	39-40
	Re-Marking	39-41
	Queue Scheduling	39-43

Configuring DAR for Voice and Video Traffic	39-47
Configuring Software QoS on Specific Interfaces	39-49
PPP and PPPoE	39-49
Frame Relay	39-52
The Switch Instance	39-53
Configuring Software QoS on Tunnels	39-55
VPN	39-55
6 to 4	39-56
Generic Router Encapsulation (GRE)	39-57
Interaction with Other Modules	39-58
Network Address Translation (NAT)	39-58
Resource Reservation Protocol (RSVP)	39-59
Priority Filters	39-59
Policy Filters	39-59
Bandwidth Limiting on Ethernet Interfaces	39-59
Counters	39-60
Debugging	39-61
Configuration Examples	39-64
1: Guaranteeing VoIP Traffic	39-65
2: Guaranteeing VoIP Traffic using DAR	39-68
3: Guaranteeing VoIP Traffic While Maintaining File Server Traffic	39-71
4: Guaranteeing VoIP Traffic over a VPN Tunnel	39-74
5: VoIP, Critical Database, and File Server Traffic	39-79
6: Multiple Applications over Frame Relay	39-82
Command Reference	39-87
add sqos interface dar	39-87
add sqos policy trafficclass	39-88
add sqos trafficclass classifier	39-89
add sqos trafficclass dar	39-90
add sqos trafficclass subclass	39-91
create sqos dar	39-92
create sqos dscpmap	39-94
create sqos meter	39-95
create sqos policy	39-98
create sqos red	39-101
create sqos trafficclass	39-103
delete sqos interface dar	39-108
delete sqos policy trafficclass	39-109
delete sqos trafficclass classifier	39-110
delete sqos trafficclass dar	39-111
delete sqos trafficclass subclass	39-112
destroy sqos dar	39-113
destroy sqos dscpmap	39-113
destroy sqos meter	39-114
destroy sqos policy	39-114
destroy sqos red	39-115
destroy sqos trafficclass	39-115
disable sqos	39-116
disable sqos debug	39-116
enable sqos	39-117
enable sqos debug	39-117
purge sqos	39-118
reset sqos counters	39-119
set sqos dar	39-121
set sqos dscpmap	39-123
set sqos interface	39-125
set sqos meter	39-127
set sqos policy	39-130
set sqos red	39-133

set sqos trafficclass	39-135
show sqos	39-139
show sqos counters	39-140
show sqos dar	39-146
show sqos dscpmap	39-148
show sqos interface	39-150
show sqos meter	39-152
show sqos policy	39-154
show sqos red	39-158
show sqos trafficclass	39-161

CHAPTER 40 Resource Reservation Protocol (RSVP)

Introduction	40-2
Resource Reservation Protocol (RSVP)	40-2
RSVP on the Router	40-5
RSVP Proxy Agent	40-7
Command Reference	40-9
create rsvp proxy	40-9
destroy rsvp proxy	40-12
disable rsvp	40-12
disable rsvp debug	40-13
disable rsvp interface	40-14
disable rsvp proxy	40-15
enable rsvp	40-15
enable rsvp debug	40-16
enable rsvp interface	40-17
enable rsvp proxy	40-18
reset rsvp proxy	40-19
set rsvp interface	40-20
set rsvp proxy	40-21
show rsvp	40-23
show rsvp counter	40-24
show rsvp interface	40-27
show rsvp path	40-28
show rsvp proxy	40-29
show rsvp proxy counter	40-31
show rsvp resv	40-32

CHAPTER 41 User Authentication

Introduction	41-3
Privilege Levels	41-3
User Level	41-3
Manager Level	41-4
Security Officer Level	41-5
Remote Security Officer Level	41-6
Operating Modes	41-7
User Authentication Facility	41-8
User Authentication Database	41-10
Adding Entries to the User Authentication Database	41-10
Modifying Entries in the User Authentication Database	41-11
Choosing Passwords	41-12
Asynchronous Port Security	41-12
Telnetting from the Router	41-13
Counters	41-14
Semipermanent Manager Port	41-14
RADIUS	41-15
TACACS	41-18
TACACS+	41-18

Token Card Authentication	41-22
Token Card Authentication on the Router	41-22
Using Token Card with TACACS+	41-23
Using Token Card with RADIUS or TACACS	41-24
Debug Support for RADIUS, TACACS and TACACS+	41-26
S/Key and OTP One-Time Password Systems	41-26
Initialising the S/Key or OTP System on the Authentication Server	41-27
Configuring S/Key and OTP on the Router	41-28
Command Reference	41-30
add radius server	41-30
add tacacs server	41-31
add tacplus server	41-32
add user	41-33
add user rso	41-36
delete radius server	41-37
delete tacacs server	41-38
delete tacplus server	41-38
delete user	41-39
delete user rso	41-40
disable radius debug	41-41
disable system security_mode	41-41
disable tacacs debug	41-42
disable tacplus	41-42
disable tacplus debug	41-42
disable user	41-43
disable user rso	41-43
enable	41-44
enable radius debug	41-45
enable system security_mode	41-46
enable tacacs debug	41-47
enable tacplus	41-47
enable tacplus debug	41-48
enable user	41-48
enable user rso	41-49
login	41-50
logoff	41-51
purge user	41-51
reset user	41-52
set manager asyn	41-53
set password	41-54
set radius	41-55
set skey	41-55
set tacplus key	41-56
set tacplus server	41-57
set tacplus telnet	41-58
set user	41-59
show manager asyn	41-62
show radius	41-63
show radius debug	41-64
show skey	41-65
show tacacs debug	41-67
show tacacs server	41-68
show tacplus	41-69
show tacplus key	41-69
show tacplus server	41-70
show tacplus telnet	41-71
show tacplus user	41-72
show user	41-73
show user rso	41-78

CHAPTER 42 **Compression and Encryption Services**

Introduction	42-2
Data Compression	42-2
Data Encryption	42-4
Symmetrical Encryption	42-5
Asymmetrical (Public Key) Encryption	42-6
Network Encryption	42-7
Authentication	42-8
Key Exchange Algorithms	42-9
Hardware Support	42-9
ENCO Services	42-10
Compression	42-11
Encryption	42-12
Authentication	42-12
Diffie-Hellman Key Exchange Algorithm	42-12
Key Creation and Storage	42-13
Access Control	42-15
User Modules	42-15
IP Payload Encryption and Virtual Private Networks	42-16
Secure Shell	42-16
PPP	42-16
Frame Relay	42-17
X.25 Link Compression	42-17
Command Reference	42-18
create enco key	42-19
destroy enco key	42-21
disable enco compstatistics	42-22
disable enco debugging	42-22
enable enco compstatistics	42-22
enable enco debugging	42-23
reset enco counters	42-24
set enco dhpadding	42-25
set enco dhpriority	42-25
set enco key	42-26
set enco sw	42-27
show enco	42-28
show enco channel	42-30
show enco counters	42-36
show enco debug	42-53
show enco key	42-54

CHAPTER 43 **Port Authentication**

Introduction	43-2
802.1x Port Based Network Access Control	43-2
The 802.1x Implementation	43-2
Port Authentication Control	43-6
The Authentication Server	43-8
The Authentication Process	43-9
802.1x Guest VLAN	43-10
MAC-Based Authentication	43-11
The MAC-Based Authentication Implementation	43-11
The MAC-Based Authentication Process	43-11
Dynamic VLAN Assignment	43-12
Port Authentication on the Router	43-13
Enable Port Authentication on the Router	43-13
Enable Port Authentication on a Port	43-14
Reauthenticate Supplicants	43-16
Setting Global 802.1x Username and Password	43-16
Debug Port Authentication	43-17
Multi-Supplicant Configuration	43-17

Configuration Examples	43-19
Port as Authenticator	43-19
Port as Supplicant	43-20
Command Reference	43-21
activate portauth port reauthenticate	43-21
disable portauth	43-22
disable portauth debug	43-23
disable portauth port	43-24
enable portauth	43-25
enable portauth debug	43-26
enable portauth port	43-27
purge portauth port	43-33
reset portauth port	43-34
reset portauth port multimib	43-35
set portauth port	43-36
set portauth port supplicantmac	43-42
set portauth username	43-45
show portauth	43-47
show portauth counter	43-49
show portauth port	43-52
show portauth port multisupplicant	43-58
show portauth timer	43-63

CHAPTER 44 **Secure Shell**

Introduction	44-2
Secure Shell on the Router	44-2
Configuring Secure Shell	44-4
Configuration Examples	44-6
Command Reference	44-10
add ssh user	44-10
delete ssh session	44-12
delete ssh user	44-12
disable ssh debug	44-13
disable ssh server	44-13
disable ssh user	44-14
enable ssh debug	44-14
enable ssh server	44-15
enable ssh user	44-16
set ssh client	44-17
set ssh server	44-18
set ssh user	44-20
show ssh	44-21
show ssh counter	44-23
show ssh session	44-30
show ssh user	44-33
ssh	44-35

CHAPTER 45	Secure Sockets Layer (SSL)	
	Introduction	45-2
	SSL Operations	45-2
	Phases	45-3
	SSL on the Router	45-5
	SSL and the Graphical User Interface	45-5
	SSL and Load Balancer	45-6
	Configuration Example	45-7
	Command Reference	45-9
	disable ssl debug	45-10
	enable ssl debug	45-10
	set ssl	45-11
	show ssl	45-12
	show ssl counters	45-14
	show ssl sessions	45-22
CHAPTER 46	Firewall	
	Introduction	46-4
	Firewall Technologies	46-4
	Policies	46-6
	Rules	46-7
	Using Limit Rules to Limit Sessions	46-12
	Access Lists	46-13
	List Files	46-13
	RADIUS Servers	46-14
	Dynamic Interfaces	46-16
	Dynamic Interface Templates	46-16
	Configuring Dynamic Interfaces	46-17
	Disabling the TCP Setup Proxy	46-18
	Firewall UDP Session Timeouts	46-18
	Multicast Packet Handling	46-19
	Enhanced Packet Fragment Handling	46-19
	Enabling the Secure Shell Server	46-20
	Network Address Translation (NAT)	46-20
	Enhanced NAT	46-23
	Network Address and Port Translation (NAPT)	46-24
	Enhanced Network Address and Port Translation (ENAPT)	46-25
	Standard NAT	46-27
	Other Advanced NAT Types	46-28
	NAT on Ethernet Interfaces	46-29
	FTP Session Handling	46-30
	PPTP Pass Through	46-31
	Universal Plug and Play (UPnP)	46-32
	SMTP Proxy	46-33
	Interaction Between the SMTP Proxy and Firewall Rules	46-33
	Protecting the Email System	46-33
	Email Relaying	46-34
	HTTP Proxy	46-34
	Firewall HTTP Proxies and Firewall Policies	46-34
	HTTP Filters	46-34
	Logging	46-35
	SIP Application Layer Gateway: VoIP Phone Calls	46-36
	Using Automatic Client Management Mode	46-37
	Using Manual Client Management Mode	46-40
	Displaying and Debugging the SIP ALG	46-41
	Attacks Recognised by the Firewall	46-42

Monitoring Firewall Activity	46-45
Notifications	46-45
Debugging	46-46
Event Triggers	46-46
Logging	46-47
Session Monitoring	46-50
Accounting	46-53
Configuration Examples	46-53
Minimum Configuration for a Small Office	46-54
Firewall with an ISP-Assigned Internet Address	46-54
Firewall with a Single Global Internet Address	46-55
Allowing Access to a WWW Server	46-55
Firewall with TCP Setup Proxy Disabled for File Sharing	46-56
Configuring a Firewall to Allow VoIP Phone Calls	46-57
Troubleshooting	46-59
Traffic Flow and Network Address Translation (NAT)	46-59
Traffic Allowed or Denied by Firewall	46-59
Traffic Logging and Firewall Alert Messages	46-61
SIP ALG and VoIP Phone Calls	46-62
Command Reference	46-63
add firewall monitor	46-63
add firewall policy apprule	46-66
add firewall policy dynamic	46-68
add firewall policy httpfilter	46-69
add firewall policy interface	46-72
add firewall policy limitrule	46-74
add firewall policy list	46-76
add firewall policy nat	46-77
add firewall policy proxy	46-80
add firewall policy rule	46-82
add firewall policy spamsources	46-96
add firewall policy udpporttimeout	46-97
create firewall policy	46-98
create firewall policy dynamic	46-99
delete firewall monitor	46-99
delete firewall policy apprule	46-100
delete firewall policy dynamic	46-101
delete firewall policy httpfilter	46-102
delete firewall policy interface	46-103
delete firewall policy limitrule	46-104
delete firewall policy list	46-105
delete firewall policy nat	46-106
delete firewall policy proxy	46-108
delete firewall policy rule	46-109
delete firewall policy spamsources	46-110
delete firewall policy udpporttimeout	46-111
delete firewall session	46-111
destroy firewall policy	46-112
destroy firewall policy dynamic	46-112
disable firewall	46-113
disable firewall monitor	46-113
disable firewall notify	46-114
disable firewall policy	46-115
disable firewall policy debug	46-117
disable firewall policy httpcookies	46-119
disable firewall policy identproxy	46-120
disable firewall policy smtprelay	46-120
disable firewall policy tcpsetupproxy	46-121
disable firewall sessionreport	46-122
disable firewall sipalg	46-122
enable firewall	46-123

enable firewall monitor	46-123
enable firewall notify	46-124
enable firewall policy	46-125
enable firewall policy debug	46-127
enable firewall policy httpcookies	46-129
enable firewall policy identproxy	46-129
enable firewall policy smtprelay	46-130
enable firewall policy tcpsetupproxy	46-131
enable firewall sessionreport	46-132
enable firewall sipalg	46-132
reset firewall policy maccache	46-133
reset firewall sipalg autoclients	46-134
reset firewall sipalg counter	46-134
set firewall maxfragment	46-135
set firewall monitor	46-136
set firewall policy	46-138
set firewall policy attack	46-140
set firewall policy limitrule	46-142
set firewall policy rule	46-144
set firewall policy smtpdomain	46-149
set firewall policy udpporttimeout	46-150
set firewall sipalg	46-151
show firewall	46-153
show firewall accounting	46-156
show firewall arp	46-158
show firewall event	46-160
show firewall monitor	46-163
show firewall policy	46-164
show firewall policy attack	46-182
show firewall policy dynamic	46-183
show firewall policy limitrule	46-184
show firewall policy list	46-186
show firewall policy maccache	46-187
show firewall policy user	46-188
show firewall policy udpporttimeout	46-189
show firewall session	46-190
show firewall sipalg	46-195
show firewall sipalg autoclients	46-199
show firewall sipalg counter	46-202

CHAPTER 47 UPnP

Introduction	47-2
Overview of UPnP	47-3
UPnP Architecture	47-3
UPnP Networking Phases	47-5
UPnP and the Firewall	47-6
UPnP on the router	47-7
Additional security configuration	47-8
Configuration Example	47-9
Command Reference	47-12
disable upnp	47-12
disable upnp action	47-13
disable upnp l4port	47-14
enable upnp	47-14
enable upnp action	47-15
enable upnp l4port	47-16
show upnp	47-17
show upnp counter	47-18
show upnp interface	47-20
show upnp interface subscriptions	47-23

CHAPTER 48 **IP Security (IPsec)**

Introduction	48-3
IP Security (IPsec)	48-4
Security Protocols and Modes	48-4
Compression Protocol	48-5
Security Associations (SA)	48-5
ISAKMP/IKE	48-6
ISAKMP	48-6
IKE	48-10
IPsec on the Router	48-12
Security Policy Database (SPD)	48-13
SA Bundles	48-16
Security through Key Management	48-16
Dynamic IP Addresses	48-17
IPsec Support for IPv6	48-18
IPsec over UDP	48-19
Pre-IPsec Security Associations	48-20
ISAKMP/IKE on the Router	48-21
ISAKMP Policies	48-21
ISAKMP Exchanges	48-24
ISAKMP Security Associations (SA)	48-25
ISAKMP Heartbeats	48-25
Responding to IPsec Packets from an Unknown Tunnel	48-26
IPsec NAT-Traversal	48-27
Basic NAT-T Operations	48-27
NAT-T on the Router	48-28
Pre-IPsec Security Associations	48-30
Configuration Examples	48-31
Setting Security	48-32
VPN-only with details about ISAKMP/IKE key management	48-33
VPN with NAT-Traversal	48-37
Troubleshooting IPsec	48-44
IPsec	48-44
ISAKMP	48-45
Command Reference	48-47
activate ipsec convertoldsa	48-47
add sa member	48-48
create ipsec bundlespecification	48-49
create ipsec policy	48-51
create ipsec saspecification	48-59
create isakmp policy	48-62
create sa	48-70
delete sa member	48-71
destroy ipsec bundlespecification	48-71
destroy ipsec policy	48-72
destroy ipsec saspecification	48-73
destroy isakmp policy	48-73
destroy sa	48-74
disable ipsec	48-74
disable ipsec oldsa	48-75
disable ipsec policy debug	48-76
disable isakmp	48-78
disable isakmp debug	48-79
disable sa debug	48-80
enable ipsec	48-80
enable ipsec oldsa	48-81
enable ipsec policy debug	48-82
enable isakmp	48-84
enable isakmp debug	48-86

enable sa debug	48-87
purge ipsec	48-87
reset ipsec counter	48-88
reset ipsec policy	48-89
reset ipsec policy counter	48-89
reset ipsec sa counter	48-90
reset isakmp counters	48-91
reset isakmp policy	48-92
set ipsec bundlespecification	48-93
set ipsec policy	48-94
set ipsec saspecification	48-102
set ipsec udpport	48-104
set isakmp policy	48-105
set sa	48-113
show ipsec	48-114
show ipsec bundlespecification	48-115
show ipsec counter	48-118
show ipsec policy	48-134
show ipsec policy counter	48-138
show ipsec policy sabundle	48-141
show ipsec sa	48-143
show ipsec sa counter	48-148
show ipsec saspecification	48-151
show isakmp	48-153
show isakmp counters	48-155
show isakmp exchange	48-185
show isakmp policy	48-192
show isakmp sa	48-197
show sa	48-202
show sa counter	48-205
show sa user	48-211

CHAPTER 49 **Public Key Infrastructure (PKI)**

Introduction	49-2
Overview of PKI	49-2
Public Keys	49-2
Certificates	49-3
Elements of a Public Key Infrastructure	49-5
Certificate Validation	49-6
Certificate Revocation Lists (CRLs)	49-6
PKI on the Router	49-7
Certificate Retrieval and Storage	49-7
Certificate Validation	49-8
Certificate Revocation Lists	49-9
Requesting a Certificate	49-9
Global PKI Parameters	49-10
Configuration Examples	49-11
Manual Enrollment	49-12
Automatic Enrollment with CMP	49-14
Command Reference	49-16
add pki certificate	49-16
add pki crl	49-18
add pki ldaprepository	49-19
create pki certificate	49-20
create pki enrollmentrequest	49-21
create pki keyupdaterequest	49-22
delete pki certificate	49-23
delete pki crl	49-23

delete pki ldaprepository	49-24
destroy pki enrollmentrequest	49-24
destroy pki keyupdaterequest	49-25
disable pki debug	49-25
enable pki debug	49-26
purge pki	49-27
set pki	49-28
set pki certificate	49-29
set pki crl	49-30
set pki ldaprepository	49-31
set system distinguishedname	49-32
show pki	49-33
show pki certificate	49-40
show pki crl	49-43
show pki enrollmentrequest	49-46
show pki keyupdaterequest	49-48
show pki ldaprepository	49-50

CHAPTER 50 Link Compression and Encryption

Introduction	50-2
Overview	50-2
Link Compression	50-3
PPP	50-3
Frame Relay	50-4
X.25	50-5
Link Encryption	50-5
Star Key Management	50-5
PPP	50-11
Frame Relay	50-11
Command Reference	50-12
create star	50-13
destroy star	50-14
disable star debugging	50-15
enable star debugging	50-15
enable star mkttransfer	50-16
set star	50-17
show star	50-19
show star counter	50-21
show star mkttransfer log	50-26
show star netkey	50-27

CHAPTER 51 Server Load Balancing

Introduction	51-3
Overview	51-3
Server Load Balancer on the Router	51-5
TCP Virtual Balancer	51-6
Route-Based Virtual Balancer	51-6
HTTP Virtual Balancer	51-7
SSL Load Balancer	51-8
Load Balancer and Firewall	51-9
Redundancy	51-10
Healthchecks	51-13
Triggers	51-14
Configuration Example	51-18
Command Reference	51-21
add loadbalancer resource	51-21
add loadbalancer respool	51-23
add loadbalancer virtualbalancer	51-24

add loadbalancer virtualbalancer httperrorcode	51-27
delete loadbalancer resource	51-28
delete loadbalancer respool	51-29
delete loadbalancer virtualbalancer	51-30
delete loadbalancer virtualbalancer httperrorcode	51-31
disable loadbalancer	51-31
disable loadbalancer debug	51-32
disable loadbalancer healthpings	51-32
disable loadbalancer redundancy	51-33
disable loadbalancer resource	51-34
disable loadbalancer virtualbalancer	51-35
enable loadbalancer	51-36
enable loadbalancer debug	51-36
enable loadbalancer healthpings	51-37
enable loadbalancer redundancy	51-38
enable loadbalancer resource	51-39
enable loadbalancer virtualbalancer	51-39
reset loadbalancer	51-40
set loadbalancer	51-41
set loadbalancer redundancy	51-42
set loadbalancer resource	51-44
set loadbalancer respool	51-45
set loadbalancer virtualbalancer	51-46
show loadbalancer	51-48
show loadbalancer affinity	51-50
show loadbalancer connections	51-52
show loadbalancer redundancy	51-53
show loadbalancer resource	51-56
show loadbalancer respool	51-59
show loadbalancer virtualbalancer	51-61

CHAPTER 52 **WAN Load Balancing**

Introduction	52-2
WAN Load Balancer Operating Principles	52-2
Load Distribution Methods	52-3
Round Robin Distribution	52-3
Weighted Lottery Distribution	52-3
Weighted Least Connect Distribution	52-4
Weighted Fast Response Distribution	52-5
Assigning Weights	52-7
Healthchecks	52-8
Operation with Other Software Features	52-9
Operation with Firewall	52-9
Operation with IP NAT	52-10
Operation with Policy Based Routing	52-10
Operation with Priority Based Routing	52-10
Operation with UPnP NAT Traversal	52-11
Configuring WAN Load Balancing	52-11
How to configure the WAN Load Balancer	52-11
Configuration Example	52-13
Command Reference	52-16
add wanlb healthcheck	52-16
add wanlb resource	52-17
delete wanlb healthcheck	52-18
delete wanlb resource	52-19
disable wanlb	52-19
disable wanlb debug	52-20
disable wanlb healthcheck	52-21
disable wanlb resource	52-22
enable wanlb	52-23

enable wanlb debug	52-24
enable wanlb healthcheck	52-25
enable wanlb resource	52-25
reset wanlb resource	52-26
reset wanlb resource counter	52-26
set wanlb	52-27
set wanlb abd	52-28
set wanlb healthcheck	52-30
set wanlb resource	52-31
show wanlb	52-32
show wanlb debug	52-33
show wanlb healthcheck	52-34
show wanlb resource	52-35
show wanlb sessions	52-42

CHAPTER 53 **Virtual Router Redundancy Protocol (VRRP)**

Introduction	53-2
Virtual Router Redundancy Protocol	53-2
Interface Monitoring	53-3
Port Monitoring	53-4
VRRP on the Router	53-5
Adopting the VRRP IP Address	53-7
Triggers	53-9
Configuration Example	53-10
Master with Backup Router	53-10
Authenticated Virtual Router with No Preferred Master	53-11
Command Reference	53-12
add vrrp	53-12
add vrrp monitoredinterface	53-13
create vrrp	53-14
delete vrrp	53-17
delete vrrp monitoredinterface	53-18
destroy vrrp	53-19
disable vrrp	53-19
disable vrrp debug	53-20
enable vrrp	53-20
enable vrrp debug	53-21
set vrrp	53-22
show vrrp	53-25

CHAPTER 54 **Ping Polling of Device Reachability**

Introduction	54-2
Configuring Ping Polling	54-2
Triggers	54-4
Logging	54-6
Interaction with Other Protocols	54-6
Ping and Traceroute	54-6
Firewalls	54-6
Configuration Example	54-7
Command Reference	54-9
add ping poll	54-9
delete ping poll	54-11
disable ping poll	54-12
disable ping poll debug	54-12
enable ping poll	54-13
enable ping poll debug	54-13
reset ping poll	54-14
set ping poll	54-15
show ping poll	54-17

CHAPTER 55 **Simple Network Management Protocol (SNMP)**

Introduction	55-3
Network Management Framework	55-3
Structure of Management Information	55-5
Names	55-6
Instances	55-7
Syntax	55-7
Access	55-8
Status	55-8
Description	55-8
The SNMP Protocol	55-8
SNMP Versions	55-9
SNMP Messages	55-9
Polling versus Event Notification	55-10
Message Format for SNMPv1 and SNMPv2c	55-10
SNMP Communities (Version v1 and v2c)	55-11
SNMPv3 Entities	55-12
SNMPv3 Message Protocol Format	55-13
SNMPv1 and SNMPv2c on the Router	55-15
SNMP MIB Views for SNMPv1 and SNMPv2c	55-15
SNMP Communities	55-16
Configuration Example (SNMPv1 and v2)	55-20
SNMPv3 on the Router	55-21
SNMP MIB Views for SNMPv3	55-21
SNMP Defined MIB Names	55-22
SNMP Groups	55-23
SNMP Users	55-23
SNMP Target Addresses	55-23
SNMP Target Params	55-23
Configuration Example (SNMPv3)	55-24
Command Reference	55-25
add snmp community	55-25
add snmp group	55-27
add snmp targetaddr	55-28
add snmp targetparams	55-29
add snmp user	55-30
add snmp view	55-32
create snmp community	55-33
delete snmp community	55-35
delete snmp group	55-36
delete snmp targetaddr	55-36
delete snmp targetparams	55-37
delete snmp user	55-37
delete snmp view	55-38
destroy snmp community	55-39
disable snmp	55-39
disable snmp authenticate_trap	55-39
disable snmp community	55-40
enable snmp	55-40
enable snmp authenticate_trap	55-41
enable snmp community	55-41
purge snmp	55-42
set snmp community	55-42
set snmp engineid	55-43
set snmp group	55-44
set snmp local	55-45
set snmp targetaddr	55-46
set snmp targetparams	55-47
set snmp user	55-48

show snmp 55-49
 show snmp community 55-52
 show snmp group 55-53
 show snmp targetaddr 55-54
 show snmp targetparams 55-55
 show snmp user 55-56
 show snmp view 55-57

CHAPTER 56 Link Layer Discovery Protocol (LLDP)

Introduction 56-3
 Link Layer Discovery Protocol 56-3
 Type Length Values 56-4
 Transmission and Reception 56-5
 Storing LLDP Information 56-7
 Configuring LLDP 56-8
 LLDP Triggers 56-10
 Cisco Discovery Protocol 56-11
 CDP Advertisements 56-11
 CDP Neighbours 56-12
 Receiving and Checking Advertisements 56-12
 Storing CDP Data 56-12
 Configuring CDP 56-13
 CDP Triggers 56-13
 Command Reference 56-15
 disable lldp cdp 56-15
 disable lldp cdp debug 56-16
 disable lldp cdp interface 56-17
 disable lldp cdp ppptemplate 56-17
 disable lldp managementaddress 56-18
 disable lldp notifications 56-19
 disable lldp port 56-20
 disable lldp portdescription 56-21
 disable lldp systemcapabilities 56-22
 disable lldp systemdescription 56-23
 disable lldp systemname 56-24
 enable lldp cdp 56-25
 enable lldp cdp debug 56-26
 enable lldp cdp interface 56-27
 enable lldp cdp ppptemplate 56-27
 enable lldp managementaddress 56-28
 enable lldp notifications 56-29
 enable lldp port 56-30
 enable lldp portdescription 56-31
 enable lldp systemcapabilities 56-32
 enable lldp systemdescription 56-33
 enable lldp systemname 56-34
 purge lldp 56-35
 reset lldp 56-35
 reset lldp cdp counters 56-35
 reset lldp cdp table 56-36
 set lldp managementaddress 56-36
 set lldp notification interval 56-37
 set lldp reinitdelay 56-37
 set lldp txdelay 56-38
 set lldp txhold 56-39
 set lldp txinterval 56-39
 show lldp 56-40
 show lldp cdp 56-47
 show lldp cdp counters 56-48

	show lldp cdp entry	56-49
	show lldp cdp interface	56-51
	show lldp cdp neighbour	56-52
	show lldp counters	56-55
	show lldp memory	56-58
	show lldp neighbour	56-59
CHAPTER 57	Network Time Protocol (NTP)	
	Introduction	57-2
	Overview	57-2
	NTP on the Router	57-4
	Configuration Example	57-4
	Troubleshooting	57-7
	Command Reference	57-8
	add ntp peer	57-8
	delete ntp peer	57-8
	disable ntp	57-9
	enable ntp	57-9
	purge ntp	57-9
	reset ntp	57-10
	set ntp utcoffset	57-10
	show ntp	57-11
CHAPTER 58	Scripting	
	Introduction	58-2
	Activating a Script at Login	58-2
	Creating Scripts	58-2
	Using Script Commands	58-3
	Using the Built-In Text Editor	58-3
	Loading from a TFTP Server	58-3
	Loading from an Asynchronous Port	58-4
	Using Scripts	58-4
	Script Parameters	58-5
	Script Control Structures	58-5
	Command Reference	58-7
	activate script	58-7
	add script	58-8
	deactivate script	58-9
	delete script	58-10
	if..then..else..endif	58-11
	set script	58-12
	show script	58-14
	wait	58-15
CHAPTER 59	Trigger Facility	
	Introduction	59-2
	Defining Triggers	59-3
	Configuration Example	59-4
	Command Reference	59-6
	activate trigger	59-6
	add trigger	59-7
	create trigger	59-8
	delete trigger	59-15
	destroy trigger	59-15
	disable trigger	59-16
	enable trigger	59-17
	purge trigger	59-17
	set trigger	59-18
	show trigger	59-24

CHAPTER 60 **Logging Facility**

Introduction	60-2
Format of Log Messages	60-3
Secure Router Log Protocol (SRLP)	60-4
Net Manage Message Protocol	60-4
Processing Log Messages	60-4
Output Definitions and Message Filters	60-4
Destinations	60-6
Configuring Output Definitions	60-8
Configuring Message Filters	60-8
Configuration Example	60-10
Command Reference	60-13
add log output	60-13
add log receive	60-17
create log output	60-19
delete log output	60-23
delete log receive	60-23
destroy log output	60-24
disable log	60-24
disable log generation	60-24
disable log output	60-25
disable log reception	60-25
enable log	60-26
enable log generation	60-26
enable log output	60-27
enable log reception	60-27
flush log output	60-28
purge log	60-28
set log output	60-29
set log receive	60-35
set log utcoffset	60-36
show log	60-37
show log counter	60-43
show log output	60-45
show log queue	60-49
show log receive	60-50
show log status	60-52

CHAPTER 61 **Terminal Server**

Introduction	61-2
TTY Devices	61-2
Multiple Sessions	61-5
Accessing Telnet Hosts and Other Services	61-6
Telnet	61-6
Remote Management	61-7
Services	61-7
Reverse Telnet	61-8
Client Command Limitations	61-9
Configuration Examples	61-10
Telnet Service	61-10
Locally Defined Service	61-10
Permanent Assignment	61-11
Remote Use of Asynchronous Services	61-12
Troubleshooting	61-14
Command Reference	61-15
connect	61-16
create service	61-17
destroy service	61-18

disable rtelnet	61-18
disable rtelnet debug	61-19
disable telnet server	61-19
disconnect	61-20
enable rtelnet	61-20
enable rtelnet debug	61-21
enable telnet server	61-21
reconnect	61-22
set service	61-23
set rtelnet	61-24
set telnet	61-25
set tty	61-26
show service	61-27
show sessions	61-28
show telnet	61-29
show tty	61-30
telnet	61-34
CHAPTER 62 Permanent Assignments	
Introduction	62-2
Overview of Permanent Assignments	62-2
Configuring a Permanent Assignment	62-3
Command Reference	62-5
add perm	62-6
delete perm	62-7
reset perm	62-7
set perm	62-8
show perm	62-9
CHAPTER 63 Test Facility	
Introduction	63-2
Ethernet Port Tests	63-4
Asynchronous Port Tests	63-6
Synchronous Interface Tests	63-7
Basic Rate ISDN Interface Tests	63-8
Primary Rate ISDN Interface Tests	63-9
Command Reference	63-10
disable test interface	63-10
enable test interface	63-11
reset test interface	63-12
show test	63-13
APPENDIX A Messages	
Introduction	A-3
Message Descriptions	A-4
smmm001–smmm255: Global Messages	A-4
s002256–s002999: Frame Relay	A-14
s003256–s003999: Point-to-Point Protocol	A-17
s004256–s004999: AppleTalk	A-21
s005256–s005999: Internet Protocol (IP)	A-24
s006256–s006999: Novell IPX	A-38
s007256–s007999: SYN Driver	A-42
s008256–s008999: DECnet	A-42
s013256–s013999: X.25 Layer 3 (DCE)	A-43
s014256–s014999: Q.931	A-45
s017256–s017999: LAPB	A-46
s018256–s018999: TEST Module	A-47

s019256–s019999: LAPD	A-49
s020256–s020999: Synchronous Tunnelling (STT)	A-53
s022256–s022999: TCP	A-53
s023256–s023999: Ethernet Driver	A-53
s024256–s024999: Permanent Assignments	A-54
s027256–s027999: Bridging	A-55
s030256–s030999: X.25 Layer 3 (DTE)	A-60
s031256–s031999: FLASH Driver	A-61
s033256–s033999: TELNET	A-63
s034256–s034999: System	A-63
s035256–s035999: Command Processor	A-66
s036256–s036999: TTY	A-66
s037256–s037999: ISDN Call Control	A-69
s038256–s038999: MIOX	A-72
s039256–s039999: BOOTP	A-74
s040256–s040999: Network Time Protocol (NTP)	A-75
s041256–s041999: BRI Driver	A-76
s042256–s042999: PRI Driver	A-77
s043256–s043999: PORT Driver	A-79
s045256–s045999: User Authentication Facility	A-82
s046256–s046999: Asynchronous Call Control	A-86
s048256–s048999: LOADER	A-90
s049256–s049999: INSTALL	A-94
s050256–s050999: Open Shortest Path First (OSPF)	A-97
s051256–s051999: RADIUS	A-101
s052256–s052999: Generic Routing Encapsulation (GRE)	A-102
s053256–s053999: Trigger Facility	A-103
s054256–s054999: Scripting	A-105
s055256–s055999: Time Division Multiplexing (TDM)	A-106
s056256–s056999: File Subsystem	A-108
s057256–s057999: Logging Facility	A-111
s058256–s058999: PING	A-114
s059256–s059999: Simple Network Management Protocol (SNMP)	A-116
s062256–s062999: Security Associations	A-119
s066256–s066999: Internet Protocol version 6 (IPv6)	A-120
s067256–s067999: Layer 2 Tunnelling Protocol (L2TP)	A-124
s068256–s068999: Asynchronous Transfer Mode (ATM)	A-125
s070256–s070999: Dynamic Host Configuration Protocol (DHCP)	A-129
s073256–s073999: Encryption	A-131
s074256–s074999: Star Key Management	A-133
s075256–s075999: Secure Shell	A-134
s076256–s076999: Resource Reservation Protocol (RSVP)	A-136
s077256–s077999: Firewall	A-136
s079256–s079999: Transaction Packet Assembler Disassembler (TPAD)	A-143
s081256–s081999: IP Security (IPsec)	A-144
s082256–s082999: ISAKMP/IKE	A-149
s083256–s083999: Finger	A-150
s084256–s084999: HTTP	A-151
s087256–s087999: Layer 3 Switching	A-152
s088256–s088999: Virtual Router Redundancy Protocol (VRRP)	A-166
s089256–s089999: VLANs	A-168
s092256–s092999: Spanning Tree Protocol (STP)	A-180
s093256–s093999: GUI	A-182
s094256–s094999: Open Systems Interconnection (OSI)	A-184
s095256–s095999: Public Key Infrastructure (PKI)	A-186
s096256–s096999: Lightweight Directory Access Protocol (LDAP)	A-187
s097256–s097999: Protocol Independent Multicast (PIM)	A-191
s100256–s100999: Generic Classifier	A-194

s102256–s102999: Switch Driver	A-196
s103256–s103999: Border Gateway Protocol version 4 (BGP-4)	A-198
s104256–s104999: Load Balancer	A-204
s110256–s110999: Voice over IP (VoIP)	A-209
s112256–s112999: S/Key	A-212
s113256–s113999: UPnP (Universal Plug and Play)	A-212
s117256–s117999: Dynamic Host Configuration Protocol v6 (DHCP6)	A-213
s118256–s118999: Port Authentication	A-215
s121256–s121999: Asymmetric Digital Subscriber Line (ADSL)	A-217
s123256–s123999: Software Quality of Service	A-218
s124256–s124999: Multiple Spanning Tree Protocol (MSTP)	A-223
s130256–s130999: WAN Load Balancing	A-223
s132256–s132999: Link Layer Discovery Protocol	A-225
s135256–s135999: Symmetrical High-speed Digital Subscriber Line	A-226

APPENDIX B Reference Tables

Module Identifiers and Names	B-2
Flash File System Message Codes	B-7
ISDN Q.931 Call Clearance Cause Codes	B-9
Log Message Types and Subtypes	B-11

APPENDIX C SNMP MIBs

Introduction	C-3
Allied Telesis Enterprise MIB	C-4
Products Subtree	C-5
AT Router Subtree	C-9
Objects Group	C-9
traps Group	C-16
sysinfo Group	C-16
arInterfaces Group	C-17
Modules Group	C-18
MIB-II MIB	C-29
Implementation	C-30
Interfaces Group MIB	C-31
Implementation	C-32
IP Forwarding Table MIB	C-33
Implementation	C-33
Ethernet-like Interface Types MIB	C-34
Implementation	C-34
Medium Attachment Unit (MAU) MIB	C-35
Implementation	C-36
Bridge MIB	C-37
Implementation	C-38
ATM MIB	C-39
Implementation	C-39
ADSL Line MIB	C-40
Implementation	C-40
SHDSL Line MIB	C-42
Implementation	C-43
Port Access Control MIB	C-44
Implementation	C-45
RMON MIB	C-46
Implementation	C-47
Frame Relay DTE MIB	C-48
Implementation	C-49
DS1, E1, DS2 and E2 Interface Types MIB	C-50
Implementation	C-51
Host Resources MIB	C-52
Implementation	C-53

SNMP v3 MIBs	C-55
Implementation	C-55
Border Gateway Protocol v4 (BGP-4) MIB	C-56
Implementation	C-57
Link Layer Discovery Protocol (LLDP) MIB	C-58
Implementation	C-58
State and Topology Change Traps	C-59

Glossary

Index