

AR400 SERIES

Software Reference

Software Release 2.7.1



AR410
AR440S
AR441S
AR450S

AR400 Series Router Software Reference for Software Release 2.7.1
Document Number C613-03091-00 REV A.

Copyright © 2005 Allied Telesyn International Corp.
19800 North Creek Parkway, Suite 200, Bothell, WA 98011, USA.

All rights reserved. No part of this publication may be reproduced without prior written permission from Allied Telesyn.

Allied Telesyn International Corp. reserves the right to make changes in specifications and other information contained in this document without prior written notice. The information provided herein is subject to change without notice. In no event shall Allied Telesyn 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 Telesyn has been advised of, known, or should have known, the possibility of such damages.

All trademarks are the property of their respective owners.

Contents

List of Figures

List of Tables

Preface

Purpose of this Manual	lxxxv
Intended Audience	lxxxvii
Structure of this Manual	lxxxvii
Where To Find More Information	xc
Standards and Protocols	xc
Supported Standards and Protocols	xc
Obtaining Copies of Internet Protocols and Standards	xciii
Background Reading	xciv
Publicly Accessible Documents	xcv
Conventions	xcv
Special Feature Licences	xcviii
Allied Telesyn Offices and Locations	xcviii
Reader's Comments	xcix

Command Summary

CHAPTER 1 **Operation**

Introduction	1-5
The Command Processor	1-5
Logging In	1-5
Normal Mode and Security Mode	1-6
Privilege Levels	1-9
Entering Commands	1-11
Aliases	1-12
Online Help	1-13
Storing and Retrieving Configuration Information	1-13
The Graphical User Interface (GUI)	1-14
Enabling and Disabling the GUI	1-14
Displaying Information about the GUI	1-14
User Authentication Facility	1-15
The User Authentication Database	1-16
Asynchronous Port Security	1-19
Telnetting from the Router	1-20
Counters	1-21
Semipermanent Manager Port	1-21
RADIUS	1-22
TACACS	1-24

TACACS+	1-25
Token Card Authentication	1-29
Token Card Authentication on the Router	1-30
Using Token Card with TACACS+	1-30
Using Token Card with RADIUS or TACACS	1-31
RADIUS, TACACS and TACACS+	
Debug Support	1-33
S/Key and OTP One-Time Password Systems	1-34
Initialising the S/Key or OTP System on the Authentication Server	1-34
Configuring S/Key and OTP on the Router	1-36
Remote Management	1-36
Monitoring and Fault Diagnosis	1-37
Event Logging	1-37
Restarts	1-37
CPU Utilisation	1-37
Memory	1-37
Flash Memory	1-38
Physical Characteristics	1-38
The File Subsystem	1-39
File Naming Conventions	1-39
Using Wildcards to Specify Groups of Files	1-41
Working With Files	1-41
Flash File System	1-42
Working with FFS Files	1-42
Compaction	1-43
FFS Messages	1-43
The Built-in Editor	1-44
HTTP Client and Server	1-45
Resolving Uniform Resource Locators (URLs)	1-46
Mail Subsystem	1-46
Configuration Examples	1-47
Loading Files onto the Router	1-48
Trivial File Transfer Protocol (TFTP)	1-49
Hypertext Transfer Protocol (HTTP)	1-49
Lightweight Directory Access Protocol (LDAP)	1-49
Software Releases and Patches	1-51
Releases	1-51
Patches	1-53
Router Startup Operations	1-53
Downloading Releases, Patches and GUI resource files into the Router ..	1-55
Install Information	1-55
Examples	1-56
Special Feature Licences	1-59
Command Reference	1-60
activate flash compaction	1-60
add alias	1-61
add radius server	1-62
add tacacs server	1-63
add tacplus server	1-64
add user	1-65
add user rso	1-67
clear flash totally	1-69
copy	1-69
create config	1-70
delete alias	1-71
delete file	1-71
delete install	1-72
delete mail	1-73
delete radius server	1-73

delete tacacs server	1-74
delete tacplus server	1-74
delete user	1-75
delete user rso	1-76
disable feature	1-77
disable gui	1-78
disable http debug	1-78
disable http server	1-79
disable ldap debug	1-79
disable mail debug	1-79
disable radius debug	1-80
disable release	1-80
disable system security_mode	1-81
disable tacacs debug	1-81
disable tacplus	1-82
disable tacplus debug	1-82
disable user	1-82
disable user rso	1-83
dump	1-83
edit	1-85
enable	1-87
enable feature	1-88
enable gui	1-88
enable http debug	1-89
enable http server	1-89
enable ldap debug	1-90
enable mail debug	1-90
enable radius debug	1-91
enable release	1-92
enable system security_mode	1-93
enable tacacs debug	1-94
enable tacplus	1-94
enable tacplus debug	1-95
enable user rso	1-95
help	1-95
load	1-96
login	1-101
logoff	1-102
mail	1-102
modify	1-104
purge file translationtable	1-105
purge ldap	1-105
purge user	1-106
rename	1-106
reset cpu utilisation	1-107
reset gui	1-107
reset http server	1-107
reset loader	1-108
reset user	1-108
restart	1-109
set config	1-110
set help	1-111
set http server	1-112
set install	1-113
set loader	1-114
set mail	1-118
set manager asyn	1-119
set password	1-120
set skey	1-120

set system contact	1-121
set system country	1-122
set system distinguishedname	1-123
set system location	1-123
set system name	1-124
set system territory	1-124
set tacplus key	1-125
set tacplus server	1-125
set tacplus telnet	1-126
set time	1-126
set user	1-127
show alias	1-130
show buffer	1-131
show config	1-133
show cpu	1-136
show debug	1-137
show exception	1-143
show feature	1-144
show ffile	1-146
show file	1-148
show flash	1-150
show flash physical	1-152
show gui	1-153
show http client	1-154
show http debug	1-155
show http server	1-156
show http server session	1-157
show install	1-158
show ldap	1-159
show ldap request	1-160
show loader	1-162
show mail	1-163
show manager asyn	1-165
show patch	1-165
show radius	1-166
show radius debug	1-167
show release	1-168
show skey	1-169
show startup	1-170
show system	1-171
show system serialnumber	1-173
show tacacs debug	1-174
show tacacs server	1-175
show tacplus key	1-175
show tacplus server	1-176
show tacplus telnet	1-177
show tacplus user	1-177
show time	1-178
show user	1-179
show user rso	1-183
upload	1-186

CHAPTER 2 Switching on the AR410

Introduction	2-3
Switch Ports	2-4
Enabling and disabling switch ports	2-4
Autonegotiation of port speed and duplex mode	2-4
Limiting Switch Traffic	2-5

Virtual Local Area Networks (VLANs)	2-6
Creating VLANs without VLAN tags	2-6
VLAN tagging	2-7
VLAN tags in the Ethernet Frame	2-8
The Layer 2 Switching Process	2-9
The Learning Process	2-9
The Forwarding Process	2-10
Quality of Service	2-10
The Egress Rules	2-11
Configuration Example	2-11
Separate LAN and DMZ VLANs	2-11
Command Reference	2-13
add vlan port	2-13
create vlan	2-14
delete vlan port	2-15
destroy vlan	2-16
disable switch ageing timer	2-16
disable switch debug	2-16
disable switch port	2-17
disable vlan debug	2-17
enable switch ageing timer	2-18
enable switch debug	2-18
enable switch port	2-18
enable vlan debug	2-19
reset switch	2-20
set switch backoff	2-20
set switch backpressure	2-20
set switch broadcast limit	2-21
set switch buffer pool	2-21
set switch excessive collision	2-22
set switch flow control	2-22
set switch port	2-23
set switch qos	2-23
set vlan port	2-25
show switch	2-25
show switch counter	2-27
show switch debug	2-29
show switch port	2-30
show switch qos	2-31
show vlan	2-31
show vlan debug	2-33

CHAPTER 3 Switching on the AR440S, AR441S and AR450S

Introduction	3-3
Switch Ports	3-4
Enabling and Disabling Switch Ports	3-4
Autonegotiation of Port Speed and Duplex Mode	3-4
Packet Storm Protection	3-5
Virtual Local Area Networks (VLANs)	3-6
VLAN Tagging	3-7
VLAN Membership using VLAN Tags	3-9
VLAN Membership of Untagged Packets	3-10
Setting up VLANs	3-11
Summary of VLAN Tagging Rules	3-13
The Layer 2 Switching Process	3-13
The Ingress Rules	3-13
The Learning Process	3-14
The Forwarding Process	3-15

Quality of Service	3-15
The Egress Rules	3-16
Triggers	3-16
Configuration Examples	3-17
Example Using One Router to Extend a Local LAN	3-17
VLAN Example Using Untagged Ports	3-18
VLAN Example Using Tagged Ports	3-20
Command Reference	3-22
add vlan port	3-23
create vlan	3-24
delete vlan port	3-25
destroy vlan	3-26
disable switch ageing timer	3-26
disable switch debug	3-27
disable switch learning	3-27
disable switch port	3-28
disable vlan debug	3-28
enable switch ageing timer	3-29
enable switch debug	3-30
enable switch learning	3-31
enable switch port	3-31
enable vlan debug	3-32
reset switch	3-32
set switch ageingtimer	3-33
set switch port	3-34
set switch qos	3-37
set vlan port	3-38
show switch	3-39
show switch debug	3-40
show switch counter	3-41
show switch fdb	3-43
show switch port	3-44
show switch port counter	3-46
show switch qos	3-49
show vlan	3-50
show vlan debug	3-52

CHAPTER 4 Port Authentication

Introduction	4-2
802.1x Port Based Network Access Control	4-2
The 802.1x Implementation	4-2
Port Authentication Control	4-6
The Authentication Server	4-8
The Authentication Process	4-9
802.1x on the Router	4-10
Enable 802.1x on the router	4-10
Enable 802.1x on a port	4-11
Reauthenticate supplicants	4-12
Set a global username and password	4-13
Debug 802.1x	4-13
Multi-supplicant configuration	4-13
Configuration Examples	4-15
Port as an Authenticator	4-15
Port as a Supplicant	4-16
Command Reference	4-18
activate portauth port reauthenticate	4-18
disable portauth	4-19
disable portauth debug port	4-19

disable portauth port	4-20
enable portauth	4-20
enable portauth debug port	4-21
enable portauth port	4-22
purge portauth port	4-26
reset portauth port	4-27
reset portauth port multimib	4-27
set portauth port	4-28
set portauth port supplicantmac	4-32
set portauth username	4-34
show portauth	4-36
show portauth counter	4-37
show portauth port	4-40
show portauth port multisupplicant	4-44
show portauth timer	4-47

CHAPTER 5 **Generic Packet Classifier**

Introduction	5-2
Configuration of Classifiers	5-2
Command Reference	5-3
create classifier	5-4
destroy classifier	5-14
set classifier	5-15
show classifier	5-22

CHAPTER 6 **Software Quality of Service (QoS)**

Introducing QoS	6-4
How a QoS Solution is Described in this Software Reference	6-4
Introducing Software QoS	6-5
When to use Software QoS	6-5
Separate Traffic—Separate Needs	6-6
Applying QoS in a Network	6-6
Local Level	6-6
Domain Level: DiffServ, TOS and 802.1p Priority	6-6
Hierarchy of a Software QoS Solution	6-10
Traffic Class Trees	6-10
Traffic Classes	6-12
Policies	6-13
Order of Classifier Matching	6-13
Dynamic Application Recognition for Voice and Video	6-14
Software QoS Processing Points	6-15
Ingress QoS	6-16
Egress QoS	6-17
Tunnel QoS	6-17
Stages of a Software QoS Solution	6-18
Packet flow	6-18
Classification: Identifying and sorting traffic	6-20
Bandwidth class	6-20
Premarking: Labelling packets before metering	6-20
Metering: Bandwidth conformance	6-21
Packet queuing	6-24
RED Curves	6-24
Dequeuing	6-26
Queue Scheduling	6-29
Remarking	6-31
Virtual Bandwidth	6-31
How to Configure a Software QoS Hierarchy	6-32
The Total Software QoS Solution	6-32
Default traffic class	6-35

How to Configure the Stages of a QoS Solution	6-36
Premarking	6-36
Metering	6-37
RED	6-40
Remarking	6-41
Queue scheduling	6-43
How to Configure DAR for Voice and Video Traffic	6-47
How to Configure Software QoS on Particular Interfaces	6-49
PPP and PPPoE	6-49
Frame Relay	6-52
The Switch Instance	6-53
How to Configure Software QoS on Tunnels	6-55
VPN	6-55
6 to 4	6-56
Generic Router Encapsulation (GRE)	6-57
Interaction with Other Modules	6-58
Network Address Translation (NAT)	6-58
Resource Reservation Protocol (RSVP)	6-59
Priority Filters	6-59
Policy Filters	6-59
Bandwidth Limiting on Ethernet Interfaces	6-59
Counters	6-60
Debugging	6-61
Network Configuration Examples	6-63
1: Guaranteeing VoIP Traffic	6-63
2: Guaranteeing VoIP Traffic using DAR	6-67
3: Guaranteeing VoIP Traffic While Maintaining File Server Traffic	6-70
4: Guaranteeing VoIP Traffic over a VPN Tunnel	6-73
5: VoIP, Critical Database, and File Server Traffic	6-78
6: Multiple Applications over Frame Relay	6-81
Command Reference	6-86
add sqos interface dar	6-86
add sqos policy trafficclass	6-87
add sqos trafficclass classifier	6-88
add sqos trafficclass dar	6-89
add sqos trafficclass subclass	6-90
create sqos dar	6-91
create sqos dscpmap	6-93
create sqos meter	6-94
create sqos policy	6-97
create sqos red	6-100
create sqos trafficclass	6-102
delete sqos interface dar	6-106
delete sqos policy trafficclass	6-107
delete sqos trafficclass classifier	6-108
delete sqos trafficclass dar	6-109
delete sqos trafficclass subclass	6-110
destroy sqos dar	6-111
destroy sqos dscpmap	6-111
destroy sqos meter	6-112
destroy sqos policy	6-112
destroy sqos red	6-113
destroy sqos trafficclass	6-113
disable sqos	6-114
disable sqos debug	6-114
enable sqos	6-115
enable sqos debug	6-115
purge sqos	6-116
reset sqos counters	6-117

set sqos dar	6-119
set sqos dscpmap	6-120
set sqos interface	6-122
set sqos meter	6-123
set sqos policy	6-130
set sqos red	6-133
set sqos trafficclass	6-135
show sqos	6-139
show sqos counters	6-140
show sqos dar	6-146
show sqos dscpmap	6-148
show sqos interface	6-150
show sqos meter	6-151
show sqos policy	6-153
show sqos red	6-156
show sqos trafficclass	6-158

CHAPTER 7 Interfaces

Introduction	7-3
Naming interfaces	7-4
Simple Interface Names	7-4
Fully Qualified Interface Names	7-5
Ethernet	7-6
Encapsulations	7-7
Configuration	7-9
Synchronous Interfaces	7-11
Encapsulations	7-12
Modem Control Signals	7-12
Configuration	7-14
Asynchronous Interfaces	7-16
Encapsulations	7-16
Configuration	7-17
Autobauding	7-21
Testing Serial Data Circuits	7-22
Carrier Detect	7-22
Loopback	7-22
Data indicators	7-22
Displaying Interfaces	7-23
Interface Link Traps	7-23
Managing Interfaces with SNMP	7-24
Command Reference	7-24
connect asyn	7-25
create eth	7-26
destroy eth	7-27
disable asyn	7-27
disable interface debug	7-28
disable interface linktrap	7-28
disable syn	7-29
disable syn debug	7-30
enable asyn	7-30
enable interface debug	7-31
enable interface linktrap	7-31
enable syn	7-32
enable syn debug	7-32
purge asyn	7-33
reset asyn	7-33
reset asyn counter	7-34
reset asyn history	7-34

reset eth	7-35
reset eth counters	7-35
reset interface counters	7-36
reset syn	7-36
reset syn counters	7-37
set asyn	7-37
set eth maxbandwidth	7-42
set eth speed	7-43
set interface mtu	7-44
set interface traplimit	7-45
set syn	7-46
show asyn	7-49
show eth configuration	7-55
show eth counters	7-57
show eth macaddress	7-63
show eth receive	7-63
show eth state	7-64
show interface	7-66
show syn	7-71
show syn counter	7-73

CHAPTER 8 **ATM over ADSL**

Introduction	8-3
What is ADSL?	8-3
ADSL Network Components	8-4
ADSL Performance	8-5
How Does ADSL Work?	8-5
ADSL Frames and Superframes	8-6
ADSL Frequency Division Multiplexing and Echo Cancellation	8-7
ADSL Network Connection Process	8-7
Dying Gasp	8-7
What is ATM?	8-8
ATM Cells	8-8
ATM channels	8-8
ATM Service Class	8-9
Data Layers above ATM	8-10
Connection Types Used over ATM	8-10
RFC 1483 Bridged or Routed - Alternative Definitions	8-11
Typical settings for ATM over ADSL	8-13
ADSL and ATM on the Router	8-13
Virtual ETH interfaces	8-14
Configuration Procedures and Examples	8-14
Configure PPPoE over ATM	8-15
Configure PPP over ATM (PPPoA)	8-17
Configure IP over ATM (IPoA)	8-18
Configure ATM RFC 1483 Routed*	8-20
After configuring ATM	8-21
Command Reference	8-21
activate atm channel oamfunction	8-22
add atm channel	8-23
create atm	8-25
delete atm channel	8-26
destroy atm	8-26
disable adsl	8-27
disable adsl debug	8-27
disable atm channel	8-28
enable adsl	8-28
enable adsl debug	8-29

enable atm channel	8-30
reset adsl	8-30
reset adsl counter	8-31
set adsl	8-32
set atm channel	8-34
show adsl	8-36
show adsl counter	8-38
show atm	8-39
show atm channel	8-41
show atm counter	8-43

CHAPTER 9 **Point-to-Point Protocol (PPP)**

Introduction	9-3
The Point-to-Point Protocol	9-3
Encapsulation	9-3
Control Protocols	9-5
LCP Options	9-6
Configuring PPP	9-7
Link Quality Management	9-9
Multilink PPP	9-9
Bandwidth Allocation Protocol	9-10
Dial-On-Demand	9-11
Link Backup	9-11
Bandwidth on Demand	9-13
Always On/Dynamic ISDN (AODI)	9-14
Synchronous Dialling	9-14
PPP Over Ethernet	9-16
PPP over Ethernet Client Mode	9-17
PPP over Ethernet Access Concentrator Mode	9-17
Templates	9-18
PPP Callback	9-19
Magic Number	9-21
Authentication Protocols	9-22
Password Authentication Protocol (PAP)	9-22
Challenge-Handshake Authentication Protocol (CHAP)	9-23
Router configuration	9-24
Assigning IP Addresses	9-27
PPP Link Management	9-29
Configuring PPP Control Protocols	9-30
Debugging PPP Links	9-30
Configuration Examples	9-33
Configuring a PPP link	9-33
Multilink Aggregation	9-36
Dial-on-Demand Links	9-38
Link Quality Monitoring	9-39
Compression and Encryption	9-39
Leased Line Backup	9-41
Bandwidth on Demand	9-43
Bandwidth on Demand with Leased Line Circuits and ISDN	9-45
Command Reference	9-47
activate ppp	9-48
add ppp	9-49
add ppp acservice	9-53
create ppp	9-55
create ppp template	9-62
delete ppp	9-69
delete ppp acservice	9-70
destroy ppp	9-71

destroy ppp template	9-71
disable ppp	9-72
disable ppp accessconcentrator	9-72
disable ppp debug	9-73
disable ppp template debug	9-74
enable ppp	9-75
enable ppp accessconcentrator	9-75
enable ppp debug	9-76
enable ppp template debug	9-78
purge ppp	9-79
reset ppp	9-80
set ppp	9-81
set ppp acservice	9-88
set ppp template	9-90
show ppp	9-96
show ppp config	9-97
show ppp count	9-103
show ppp debug	9-117
show ppp idletimer	9-118
show ppp limits	9-119
show ppp multilink	9-120
show ppp nameserver	9-122
show ppp pppoe	9-123
show ppp template	9-124
show ppp txstatus	9-128
show ppp utilisation	9-129

CHAPTER 10 **Frame Relay (FR)**

Introduction	10-3
Encapsulation	10-4
Data Link Connections	10-6
The Local Management Interface (LMI)	10-8
Logical Interfaces	10-9
Disabling or Resetting	
a Frame Relay Interface	10-9
Disabling or Resetting a Frame Relay DLC	10-10
Slow-Start Mechanism	10-10
Congestion Detection	10-11
Detection using CLLM messages	10-11
Detection using BECN bits	10-12
Congestion Control Scheme	10-13
Frame Relay on the Router	10-15
Encryption and	
Compression over Frame Relay	10-16
Troubleshooting Frame Relay Networks	10-16
Configuring Frame Relay	10-17
Configuration Examples	10-20
Frame Relay without an LMI	10-20
Frame Relay with an LMI	10-23
Using Frame Relay Logical Interfaces	10-25
Command Reference	10-26
add framerelay dlc	10-26
add framerelay li	10-28
create framerelay	10-28
delete framerelay dlc	10-31
delete framerelay li	10-32
destroy framerelay	10-32
disable framerelay	10-33

disable framerelay congestioncontrol	10-34
disable framerelay debug	10-34
disable framerelay dlc	10-35
disable framerelay dlc debug	10-35
disable framerelay li debug	10-37
disable framerelay slowstart	10-37
enable framerelay	10-38
enable framerelay congestioncontrol	10-38
enable framerelay debug	10-38
enable framerelay dlc	10-39
enable framerelay dlc debug	10-40
enable framerelay li debug	10-41
enable framerelay slowstart	10-42
reset framerelay	10-42
reset framerelay dlc	10-44
set framerelay	10-45
set framerelay dlc	10-48
show framerelay	10-49
show framerelay dlc	10-59
show framerelay li	10-66

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

Introduction	11-4
Basic Rate Access	11-4
Primary Rate Access	11-7
ISDN on the Router	11-13
BRI Physical Layer	11-15
Configuring and Controlling the Basic Rate Interface	11-15
Examining the Status of the Basic Rate Interface	11-18
Monitoring Operation of the Basic Rate Interface	11-19
PRI Physical Layer	11-20
Configuring and Controlling the Primary Rate Interface	11-20
Examining the Status of the Primary Rate Interface	11-23
Monitoring Operation of the Primary Rate Interface	11-24
LAPD	11-25
BRI Versus PRI	11-26
Operation	11-26
Packet mode support	11-26
Fault Finding	11-27
Default Setup	11-27
Addressing	11-28
Frame Control Fields	11-29
Non-Associated Signalling	11-29
Q.931	11-31
Service Profile Identifiers (SPIDs)	11-33
Profiles That Require SPIDs	11-33
Definition of SPIDs	11-33
SPID Initialisation	11-34
SPID Debugging	11-34
Automatic ISDN switch Detection	11-37
Call Control	11-38
Call Logging	11-42
Using a Domain Name Server	11-42
Slotted Interface Numbering	11-43
Always On/Dynamic ISDN (AODI)	11-43
Components of AODI	11-43
Configuring AODI	11-45
Data Over Voice	11-47

Configuration Examples	11-48
A Basic ISDN Setup	11-48
Refining the ISDN Setup	11-56
Command Reference	11-58
activate isdn call	11-58
activate q931 aspid	11-59
activate q931 message	11-59
add isdn call	11-60
add isdn clilist	11-66
add isdn domainname	11-67
add lapd tei	11-67
add lapd xspid	11-68
add lapd xtei	11-68
deactivate isdn call	11-69
delete isdn call	11-69
delete isdn clilist	11-70
delete isdn domainname	11-70
delete lapd tei	11-71
delete lapd xspid	11-71
delete lapd xtei	11-72
disable bri ctest	11-72
disable bri debug	11-73
disable bri test	11-73
disable isdn call	11-74
disable isdn log	11-74
disable pri ctest	11-75
disable pri debug	11-76
disable pri test	11-76
disable q931 debug	11-77
enable bri ctest	11-78
enable bri debug	11-79
enable bri test	11-80
enable isdn call	11-81
enable isdn log	11-82
enable pri ctest	11-82
enable pri debug	11-83
enable pri test	11-84
enable q931 aspid	11-85
enable q931 debug	11-86
reset bri	11-91
reset bri counter	11-91
reset pri	11-92
reset pri counter	11-92
reset q931	11-93
set bri	11-93
set isdn call	11-95
set isdn domainname	11-101
set isdn log	11-101
set lapd	11-102
set pri	11-104
set q931	11-107
show bri configuration	11-110
show bri counter	11-111
show bri ctest	11-116
show bri debug	11-117
show bri state	11-118
show bri test	11-121
show isdn call	11-123
show isdn clilist	11-127

show isdn domainname	11-128
show isdn log	11-129
show lapd	11-130
show lapd count	11-132
show lapd state	11-134
show pri configuration	11-135
show pri counter	11-136
show pri ctest	11-145
show pri debug	11-147
show pri state	11-147
show pri test	11-153
show q931	11-155
show q931 spid	11-158

CHAPTER 12 **X.25**

Introduction	12-3
LAPB	12-4
DCE Mode	12-4
DTE Mode	12-5
DTE Addresses	12-7
X.25 DCE Route Mapping	12-7
Encapsulations	12-8
Configuring LAPB	12-9
Configuring an Interface for LAPB	12-10
Configuring LAPB Interface Parameters	12-10
Configuring X.25 DCE	12-11
Configure an LAPB Interface	12-11
Configure the X.25 DCE Interface	12-11
Configuring DTE Addresses on DCEs	12-12
Configuring X.25 Route Mapping	12-13
Configuring X.25 DCE TCP Keepalive parameters	12-13
Displaying and Debugging X.25 DCE Interfaces	12-13
Configuring X.25 DTE	12-14
Configure an LAPB Interface	12-14
Configure the X.25 DTE Interface	12-14
Configuring Call Parameter Entries	12-15
Configuring Permanent Virtual Circuits	12-15
Hunt Groups	12-16
Configuration Examples	12-18
A Basic X.25 Setup	12-18
An Extended X.25 Setup	12-24
X.25 over ISDN D Channel	12-30
X.25 Hunt Groups	12-31
Command Reference	12-38
activate x25c test	12-38
activate miox circuit	12-39
add miox circuit	12-40
add x25c dteaddress	12-41
add x25c huntgroup	12-42
add x25c route	12-43
add x25t cpar	12-44
create lapb	12-45
create x25c	12-46
create x25c huntgroup	12-48
create x25t	12-49
deactivate miox circuit	12-50
delete miox circuit	12-51
delete x25c dteaddress	12-52

delete x25c huntgroup	12-53
delete x25c route	12-53
delete x25t cpar	12-54
destroy lapb	12-54
destroy x25c	12-55
destroy x25c huntgroup	12-55
destroy x25t	12-55
disable miox circuit	12-56
disable x25c debug	12-56
enable miox circuit	12-57
enable x25c debug	12-58
reset lapb	12-58
reset x25t	12-58
set lapb	12-59
set miox	12-60
set miox circuit	12-61
set x25c	12-63
set x25c huntgroup	12-65
set x25c tcpkeepalive	12-66
set x25t	12-66
set x25t cpar	12-68
show lapb	12-68
show miox	12-73
show miox count	12-74
show miox circuit	12-76
show x25c	12-80
show x25c counter	12-81
show x25c dteaddress	12-84
show x25c huntgroup	12-85
show x25c path	12-86
show x25c route	12-87
show x25c state	12-88
show x25c tcpkeepalive	12-89
show x25t	12-90
show x25t cpar	12-94

CHAPTER 13 Synchronous Tunnelling

Introduction	13-2
Synchronous Tunnelling on the Router	13-2
Configuration Example	13-3
Command Reference	13-4
add stt	13-4
delete stt	13-5
reset stt	13-6
set stt	13-6
show stt	13-7

CHAPTER 14 Internet Protocol (IP)

Introduction	14-5
The Internet	14-5
Addressing	14-8
Subnets	14-10
Multihoming	14-11
Local Interfaces	14-11
Address Resolution Protocol (ARP)	14-12
MAC Address Logging	14-13
DHCP Client	14-13
ICMP	14-14

ICMP Router Discovery Advertisements	14-15
Routing	14-17
Types of Routes	14-17
The Routing Table	14-18
Configuring Static Routes	14-18
Caching Routes	14-19
Dynamic Routing Protocols	14-19
Setting Preference of Dynamically-Learned Routes	14-20
Displaying Route Information	14-20
Equal Cost Multipath Routing	14-21
Routing Information Filters	14-22
Route filters	14-22
Trusted routers	14-23
RIP	14-24
EGP	14-25
OSPF	14-25
Metrics	14-26
OSPF Auto Cost Calculation	14-26
Policy-Based Routing	14-27
Priority-Based Routing	14-28
Route Templates	14-29
VLAN Tagging on Eth Interfaces	14-30
Example	14-30
Named Hosts	14-31
DNS Relay Agent	14-33
DNS Caching	14-33
Server Selection	14-34
Traffic Filters	14-35
SNMP	14-37
Control and Debug Commands	14-37
Ping and Trace Route	14-38
Finger	14-39
Example	14-39
Security Options	14-41
Security Associations	14-41
Broadcast Forwarding	14-42
Examples	14-43
BOOTP Relay Agent	14-45
IP Multicasting	14-47
Static Multicast Forwarding	14-47
Network Address Translation	14-48
Remote Address Assignment	14-51
IP Address Pools	14-51
Configuration Examples	14-53
A Basic TCP/IP Setup	14-53
Troubleshooting	14-56
Configuring IP Filters	14-58
Command Reference	14-62
add bootp relay	14-62
add ip advertise interface	14-63
add ip arp	14-64
add ip dns	14-65
add ip egp	14-67
add ip filter	14-68
add ip helper	14-74
add ip host	14-76
add ip interface	14-77
add ip local	14-82
add ip nat	14-83

add ip rip	14-86
add ip route	14-88
add ip route filter	14-90
add ip route template	14-92
add ip sa	14-94
add ip trusted	14-95
create ip pool	14-96
delete bootp relay	14-96
delete ip advertise interface	14-97
delete ip arp	14-97
delete ip dns	14-97
delete ip egp	14-98
delete ip filter	14-99
delete ip helper	14-100
delete ip host	14-101
delete ip interface	14-101
delete ip local	14-102
delete ip nat	14-103
delete ip rip	14-104
delete ip route	14-105
delete ip route filter	14-106
delete ip route template	14-107
delete ip sa	14-107
delete ip trusted	14-108
delete tcp	14-109
destroy ip pool	14-109
disable bootp relay	14-109
disable ip	14-110
disable ip advertise	14-110
disable ip arp log	14-111
disable ip debug	14-111
disable ip dnsrelay	14-111
disable ip echoreply	14-112
disable ip egp	14-112
disable ip exportrip	14-112
disable ip fofilter	14-113
disable ip forwarding	14-114
disable ip helper	14-114
disable ip icmpreply	14-115
disable ip interface	14-115
disable ip nat	14-116
disable ip remoteassign	14-117
disable ip route	14-117
disable ip srcroute	14-118
disable telnet server	14-118
enable bootp relay	14-119
enable ip	14-119
enable ip advertise	14-120
enable ip arp log	14-120
enable ip debug	14-120
enable ip dnsrelay	14-121
enable ip echoreply	14-121
enable ip egp	14-121
enable ip exportrip	14-122
enable ip fofilter	14-122
enable ip forwarding	14-123
enable ip helper	14-123
enable ip icmpreply	14-124
enable ip interface	14-124

enable ip nat	14-125
enable ip remoteassign	14-126
enable ip route	14-126
enable ip srcroute	14-127
enable telnet server	14-127
finger	14-128
ping	14-129
purge bootp relay	14-131
purge ip	14-131
reset ip	14-132
reset ip counter	14-132
reset ip interface	14-133
set bootp maxhops	14-133
set ip advertise interface	14-134
set ip arp	14-135
set ip arp timeout	14-136
set ip dns	14-137
set ip dns cache	14-138
set ip dnsrelay	14-139
set ip filter	14-140
set ip host	14-144
set ip interface	14-145
set ip local	14-149
set ip nameserver	14-151
set ip nat maxfragments	14-152
set ip rip	14-153
set ip riptimer	14-155
set ip route	14-156
set ip route filter	14-158
set ip route preference	14-160
set ip route template	14-161
set ip secondarynameserver	14-162
set ping	14-163
set trace	14-165
show bootp relay	14-166
show ip	14-168
show ip advertise	14-171
show ip arp	14-172
show ip counter	14-173
show ip debug	14-182
show ip dns	14-183
show ip dns cache	14-184
show ip egg	14-185
show ip filter	14-186
show ip helper	14-188
show ip host	14-189
show ip icmpreply	14-190
show ip interface	14-191
show ip nat	14-195
show ip pool	14-199
show ip rip	14-201
show ip rip counter	14-203
show ip riptimer	14-205
show ip route	14-206
show ip route filter	14-210
show ip route multicast	14-211
show ip route preference	14-212
show ip route template	14-212
show ip sa	14-214

show ip trusted	14-215
show ip udp	14-215
show ping	14-216
show tcp	14-218
show trace	14-223
stop ping	14-224
stop trace	14-225
trace	14-225

CHAPTER 15 Internet Protocol Version 6 (IPv6)

Introduction	15-3
Overview of IPv6	15-3
The 6bone	15-4
IPv6 Addresses and Prefixes	15-4
IPv6 Headers	15-6
The Internet Control Message Protocol (ICMPv6)	15-8
IPv6 Routing	15-11
IPv6 Filtering	15-11
Integration of IPv4 and IPv6	15-12
IPv6 on the Router	15-12
Enabling IPv6	15-13
IPv6 Interfaces and Addresses	15-13
Extension Header Processing	15-15
Routing Table Processing and RIPv6	15-15
Neighbour Discovery	15-16
IPv6 Filtering	15-17
IPv6 Fragmentation	15-18
Telnet v6	15-18
Ping	15-19
Secure Shell	15-20
Tunnelling IPv6 packets over IPv4	15-21
6-to-4	15-21
Static Tunnelling	15-22
Configuration Examples	15-23
Basic Routing	15-23
Dynamic Routing with RIPv6	15-24
Dynamic (6-to-4) Tunnelling over an IPv4 Network	15-28
Static Tunnelling over an IPv4 Network	15-30
IPv6 Filters	15-32
Command Reference	15-34
add ipv6 6to4	15-34
add ipv6 filter	15-35
add ipv6 host	15-40
add ipv6 interface	15-41
add ipv6 nd	15-43
add ipv6 prefix	15-44
add ipv6 rip	15-45
add ipv6 route	15-46
add ipv6 tunnel	15-48
create ipv6 interface	15-49
delete ipv6 6to4	15-50
delete ipv6 filter	15-50
delete ipv6 host	15-51
delete ipv6 interface	15-51
delete ipv6 nd	15-52
delete ipv6 prefix	15-53

delete ipv6 rip	15-53
delete ipv6 route	15-54
delete ipv6 tunnel	15-55
destroy ipv6 interface	15-55
disable ipv6	15-56
disable ipv6 advertise	15-56
disable ipv6 debug	15-57
disable ipv6 mtudiscovery	15-57
disable ipv6 rip	15-58
enable ipv6	15-58
enable ipv6 advertise	15-58
enable ipv6 debug	15-59
enable ipv6 mtudiscovery	15-59
enable ipv6 rip	15-60
reset ipv6 ndcache	15-60
set ipv6 filter	15-61
set ipv6 interface	15-64
set ipv6 mtu	15-65
set ipv6 nd	15-66
set ipv6 prefix	15-68
set ipv6 route preference	15-69
show ipv6	15-70
show ipv6 counter	15-72
show ipv6 filter	15-76
show ipv6 host	15-78
show ipv6 interface	15-79
show ipv6 multicast	15-81
show ipv6 ndcache	15-82
show ipv6 ndconfig	15-83
show ipv6 rip	15-85
show ipv6 route	15-87
show ipv6 route multicast	15-88
show ipv6 route preference	15-90
show ipv6 tunnel	15-91

CHAPTER 16 Ping Polling of Device Reachability

Introduction	16-2
Configuring Ping Polling	16-2
Triggers	16-4
Logging	16-5
Interaction with Other Protocols	16-6
Ping and Traceroute	16-6
Firewalls	16-6
Configuration Example	16-7
Command Reference	16-9
add ping poll	16-9
delete ping poll	16-11
disable ping poll	16-12
disable ping poll debug	16-12
enable ping poll	16-13
enable ping poll debug	16-13
reset ping poll	16-14
set ping poll	16-14
show ping poll	16-16

CHAPTER 17 **IP Multicasting**

Introduction	17-3
References	17-3
IP Multicast Routing	17-4
Interoperability between Multicast Routing Protocols	17-5
Distance Vector Multicast Routing Protocol (DVMRP)	17-5
Configuring DVMRP	17-6
Protocol Independent Multicast (PIM)	17-7
PIM Sparse Mode	17-8
PIM Sparse Mode Roles	17-8
PIM Sparse Mode Operation	17-10
Configuring PIM Sparse Mode	17-12
Logging and SNMP Traps for PIM-SM	17-16
PIM Dense Mode	17-17
Configuring PIM Dense Mode	17-18
Internet Group Management Protocol (IGMP)	17-20
Static IGMP	17-20
Configuring IGMP	17-21
Configuring Static IGMP	17-22
IGMP Snooping	17-22
IGMP Snooping All-groups	17-24
IGMP Proxy	17-24
Configuration Examples	17-26
Multicasting using DVMRP	17-26
Protocol Independent Multicast (PIM)	17-30
Command Reference	17-38
add dvmrp interface	17-38
add igmpsnooping routeraddress	17-39
add pim bsr candidate	17-39
add pim interface	17-40
add pim rpcandidate	17-42
delete dvmrp interface	17-43
delete igmpsnooping routeraddress	17-44
delete pim bsr candidate	17-44
delete pim interface	17-45
delete pim rpcandidate	17-45
disable dvmrp	17-46
disable dvmrp debug	17-46
disable igmpsnooping	17-47
disable ip igmp	17-48
disable ip igmp allgroup	17-48
disable ip igmp debug	17-49
disable ip igmp interface	17-49
disable pim	17-50
disable pim debug	17-50
enable dvmrp	17-51
enable dvmrp debug	17-51
enable igmpsnooping	17-52
enable ip igmp	17-53
enable ip igmp allgroup	17-53
enable ip igmp debug	17-53
enable ip igmp interface	17-54
enable pim	17-55
enable pim debug	17-55
purge dvmrp	17-56
purge pim	17-56
reset dvmrp interface	17-57
reset pim interface	17-58
set dvmrp interface	17-58

set ip igmp	17-59
set igmpsnooping routermode	17-60
set pim	17-61
set pim log	17-63
set pim bsrcandidate	17-63
set pim interface	17-64
set pim rpcandidate	17-65
show dvmrp	17-66
show dvmrp counters	17-67
show dvmrp debug	17-68
show dvmrp forwarding	17-68
show dvmrp interface	17-69
show dvmrp neighbour	17-70
show dvmrp route	17-71
.show igmpsnooping routeraddress	17-72
show ip igmp	17-73
show ip igmp debug	17-76
show pim	17-77
show pim bsrcandidate	17-78
show pim config	17-79
show pim counters	17-79
show pim debug	17-83
show pim interface	17-84
show pim neighbour	17-86
show pim route	17-87
show pim rpcandidate	17-92
show pim rpset	17-93
show pim staterefresh	17-95
show pim timer	17-96

CHAPTER 18 IPv6 Multicasting

Introduction	18-3
Overview of IPv6 Multicast Routing	18-3
Interoperability between Multicast Routing Protocols	18-4
Multicast Listener Discovery (MLD)	18-5
Queries and Reports	18-5
Configuring MLD	18-6
Protocol Independent Multicast Sparse Mode (PIM-SM)	18-7
Configuring PIM Sparse Mode	18-7
Protocol Independent Multicast Dense Mode (PIM-DM)	18-11
Configuring PIM Dense Mode	18-11
Configuration Examples	18-14
Command Reference	18-24
add pim6 bsrcandidate	18-24
add pim6 interface	18-24
add pim6 rpcandidate	18-26
delete pim6 bsrcandidate	18-27
delete pim6 interface	18-27
delete pim6 rpcandidate	18-28
disable ipv6 mld	18-28
disable ipv6 mld debug	18-29
disable ipv6 mld interface	18-29
disable pim6	18-30
disable pim6 debug	18-30
enable ipv6 mld	18-30
enable ipv6 mld debug	18-31
enable ipv6 mld interface	18-31
enable pim6	18-32

enable pim6 debug	18-32
purge pim6	18-33
reset pim6 interface	18-34
set ipv6 mld	18-34
set ipv6 mld interface	18-36
set pim6	18-36
set pim6 bsrcandidate	18-38
set pim6 interface	18-38
set pim6 rpcandidate	18-39
show ipv6 mld	18-40
show ipv6 mld config	18-43
show ipv6 mld counters	18-44
show ipv6 mld debug	18-45
show pim6	18-45
show pim6 bsrcandidate	18-46
show pim6 config	18-47
show pim6 counters	18-48
show pim6 debug	18-51
show pim6 interface	18-52
show pim6 neighbour	18-53
show pim6 route	18-54
show pim6 rpcandidate	18-60
show pim6 rpset	18-60
show pim6 staterefresh	18-62
show pim6 timer	18-63

CHAPTER 19 **Novell IPX**

Introduction	19-3
The IPX Protocol	19-3
Addressing in a Novell Network	19-4
Interfaces and Circuits	19-5
Routing	19-5
Service Advertisement	19-7
Traffic Filters	19-8
RIP and SAP Filters	19-8
Wildcard Expressions	19-9
RIP Filters	19-10
SAP Filters	19-10
Global Versus Circuit-Specific Filters	19-11
Dial-on-Demand IPX	19-11
SPX Spoofing with Dial-on-Demand IPX	19-12
Troubleshooting SPX Spoofing	19-13
Extended PING for IPX	19-15
Counters and the MIB	19-16
Configuration Examples	19-16
A Basic IPX Setup	19-16
IPX Dial-On-Demand	19-21
Command Reference	19-30
add ipx circuit	19-30
add ipx exclusion	19-34
add ipx inclusion	19-35
add ipx rip	19-36
add ipx route	19-37
add ipx sap	19-38
add ipx service	19-39
delete ipx circuit	19-41
delete ipx exclusion	19-41
delete ipx inclusion	19-42

delete ipx rip	19-43
delete ipx route	19-44
delete ipx sap	19-44
delete ipx service	19-45
disable ipx	19-45
disable ipx circuit	19-46
enable ipx	19-46
enable ipx circuit	19-46
purge ipx	19-47
reset ipx	19-48
set ipx circuit	19-48
set ipx grip gsap	19-52
set ipx rip	19-52
set ipx sap	19-53
show ipx	19-54
show ipx cache	19-56
show ipx callog	19-56
show ipx circuit	19-60
show ipx counter	19-62
show ipx exclusion	19-65
show ipx inclusion	19-66
show ipx rip	19-67
show ipx route	19-68
show ipx sap	19-69
show ipx service	19-70
show ipx spxspoof	19-71

CHAPTER 20 **DECnet**

Introduction	20-2
Overview of a DECnet Network	20-2
DECnet Addresses	20-3
Routing and the Default Router	20-3
Routes and Routing Tables	20-4
Filters	20-5
Managing the Router	20-5
Counters	20-5
Timers	20-6
Costs	20-6
Configuration Examples	20-9
A Basic DECnet Setup	20-9
Troubleshooting	20-11
Refining the DECnet Setup	20-12
Command Reference	20-14
add decnet exclusion	20-14
add decnet inclusion	20-15
add decnet interface	20-16
add decnet lpn	20-17
delete decnet exclusion	20-18
delete decnet inclusion	20-19
delete decnet interface	20-20
delete decnet lpn	20-21
disable decnet	20-21
enable decnet	20-22
purge decnet	20-22
reset decnet	20-23
set decnet	20-24
set decnet interface	20-26
show decnet	20-28

show decnet counter	20-29
show decnet exclusion	20-31
show decnet inclusion	20-32
show decnet interface	20-33
show decnet lpn	20-34
show decnet route	20-35

CHAPTER 21 **Terminal Server**

Introduction	21-2
TTY Devices	21-2
Command Line Editing and Recall	21-5
Multiple Sessions	21-6
Accessing Telnet Hosts and Other Services	21-7
Telnet	21-7
Services	21-8
Reverse Telnet	21-9
Client command limitations	21-9
Configuration Examples	21-10
Telnet Service	21-10
Locally Defined Service	21-10
Permanent Assignment	21-11
Remote Use of Asynchronous Services	21-12
Troubleshooting	21-14
Command Reference	21-15
connect	21-15
create service	21-16
destroy service	21-17
disable rtelnet	21-18
disable rtelnet debug	21-18
disable telnet server	21-19
disconnect	21-19
enable rtelnet	21-20
enable rtelnet debug	21-20
enable telnet server	21-21
reconnect	21-21
set service	21-21
set telnet	21-22
set tty	21-23
show service	21-24
show sessions	21-25
show telnet	21-26
show tty	21-27
telnet	21-31

CHAPTER 22 **Printer Server**

Introduction	22-2
Line Printer Daemon (LPD)	22-2
LPD on the Router	22-3
Configuring LPD	22-3
Printer Operation	22-6
Troubleshooting	22-7
Stream Printing	22-8
Stream Printing on the Router	22-9
Configuring Stream Printing	22-9
Permanent Assignments	22-11
Setting up a Permanent Assignment	22-11

Command Reference	22-13
add perm	22-13
add stream	22-14
create lpd	22-15
delete perm	22-16
delete stream	22-16
destroy lpd	22-17
disable lpd	22-17
enable lpd	22-18
reset lpd	22-18
reset perm	22-19
reset stream	22-19
set lpd	22-20
set perm	22-21
show lpd	22-21
show perm	22-22
show stream	22-23
 CHAPTER 23 Open Shortest Path First (OSPF)	
Introduction	23-3
OSPF Features	23-3
Adjacency and Designated Routers	23-5
Link State Advertisements	23-6
OSPF Packet Types	23-7
OSPF States	23-8
OSPF Metrics	23-9
OSPF Auto Cost Calculation	23-9
Routing with OSPF	23-10
Addressless Interfaces	23-10
Using OSPF and RIP	23-11
Importing BGP routes into OSPF	23-11
OSPF On Demand Circuits	23-13
Configuration Examples	23-15
A Basic OSPF Network	23-15
An OSPF Network with Addressless PPP Links	23-16
An OSPF Network with Virtual Links	23-17
Command Reference	23-20
add ospf area	23-20
add ospf host	23-21
add ospf interface	23-22
add ospf neighbour	23-26
add ospf range	23-27
add ospf stub	23-28
delete ospf area	23-29
delete ospf host	23-29
delete ospf interface	23-30
delete ospf neighbour	23-31
delete ospf range	23-31
delete ospf stub	23-32
disable ospf	23-32
disable ospf debug	23-33
disable ospf interface	23-33
disable ospf log	23-34
enable ospf	23-35
enable ospf debug	23-35
enable ospf interface	23-36
enable ospf log	23-36
purge ospf	23-37

reset ospf	23-37
reset ospf counter	23-38
reset ospf interface	23-38
set ospf	23-39
set ospf area	23-41
set ospf host	23-42
set ospf interface	23-43
set ospf neighbour	23-46
set ospf range	23-47
set ospf stub	23-48
show ospf	23-49
show ospf area	23-51
show ospf debug	23-53
show ospf host	23-53
show ospf interface	23-55
show ospf lsa	23-59
show ospf neighbour	23-63
show ospf range	23-64
show ospf route	23-65
show ospf stub	23-67

CHAPTER 24 Bridging

Introduction	24-3
Bridging on the Router	24-4
Virtual Ports and Switch Ports	24-4
LAN-to-LAN Bridging	24-5
WAN-to-WAN Bridging	24-7
Bridge Learning and Forwarding	24-7
The Learning Process	24-8
The Forwarding Process	24-8
Filtering	24-9
Telnet to a Router Bridging IP	24-10
Spanning Tree Protocol	24-10
Electing the Root Bridge and Designated Bridge	24-11
Configuration Examples	24-12
A Basic LAN Bridge Setup	24-12
Bridging in a Meshed Network with Spanning Tree	24-13
A Bridge Setup Using Filters	24-15
Command Reference	24-18
add bridge filter	24-18
add bridge group	24-20
add bridge port	24-21
add bridge protocol	24-22
add bridge station	24-24
delete bridge filter	24-25
delete bridge group	24-25
delete bridge port	24-26
delete bridge protocol	24-26
delete bridge station	24-26
disable bridge	24-27
disable bridge learning	24-27
disable bridge spanning	24-28
enable bridge	24-28
enable bridge learning	24-28
enable bridge spanning	24-29
purge bridge	24-29
reset bridge	24-30
set bridge ageingtimer	24-30

set bridge filter	24-30
set bridge group	24-33
set bridge port	24-33
set bridge protocol	24-34
set bridge spanning	24-35
show bridge	24-36
show bridge counter	24-37
show bridge filter	24-40
show bridge group	24-42
show bridge port	24-44
show bridge protocol	24-46
show bridge spanning	24-47
show bridge station	24-49

CHAPTER 25 **Compression and Encryption Services**

Introduction	25-2
Data Compression	25-2
Data Encryption	25-5
Symmetrical Encryption	25-5
Asymmetrical (Public Key) Encryption	25-7
Network Encryption	25-7
Authentication	25-8
Key Exchange Algorithms	25-9
Hardware Support	25-10
Mini Accelerator Cards (MACs)	25-10
Hardware Control and Monitoring	25-11
ENCO Services	25-11
Compression	25-12
Encryption	25-13
Authentication	25-13
Diffie-Hellman Key Exchange Algorithm	25-13
Key Creation and Storage	25-14
Access Control	25-16
User Modules	25-17
IP Payload Encryption and Virtual Private Networks	25-17
Secure Shell	25-17
PPP	25-17
Frame Relay	25-18
X.25 Link Compression	25-18
Command Reference	25-19
create enco key	25-20
destroy enco key	25-22
disable enco compstatistics	25-23
disable enco debugging	25-23
enable enco compstatistics	25-23
enable enco debugging	25-24
reset enco counters	25-24
set enco dhpadding	25-25
set enco dhpriority	25-26
set enco key	25-26
set enco sw	25-27
show enco	25-28
show enco channel	25-30
show enco counters	25-35
show enco key	25-54

CHAPTER 26 Test Facility

Introduction	26-2
Ethernet Port Tests	26-4
Asynchronous Port Tests	26-6
Synchronous Port Tests	26-7
Basic Rate ISDN Port Tests	26-8
Primary Rate ISDN Port Tests	26-10
MAC Card Tests	26-10
Command Reference	26-11
disable test interface	26-11
enable test interface	26-12
reset test interface	26-13
show test	26-14

CHAPTER 27 Network Time Protocol (NTP)

Introduction	27-2
Overview of the Network Time Protocol	27-2
NTP on the Router	27-4
Configuration Example	27-4
Command Reference	27-6
add ntp peer	27-7
delete ntp peer	27-7
disable ntp	27-7
enable ntp	27-8
purge ntp	27-8
reset ntp	27-8
set ntp utcoffset	27-9
show ntp	27-9

CHAPTER 28 Asynchronous Call Control

Introduction	28-2
Call Definitions	28-2
Authenticating Incoming Calls	28-5
RADIUS Authentication	28-5
RADIUS Accounting	28-6
Using Modem Scripts	28-6
Bidirectional Calls	28-8
Interface with Higher Layers	28-9
Using a Domain Name Server	28-10
Configuration Examples	28-10
Defining an ACC Call	28-10
Assigning IP Addresses	28-12
Dial-in IPX	28-13
Router-to-Router PPP	28-13
Command Reference	28-15
activate acc call	28-16
add acc call	28-16
add acc domainname	28-19
add acc script	28-20
deactivate acc call	28-21
delete acc call	28-22
delete acc domainname	28-22
delete acc script	28-23
disable acc call	28-23
disable acc call debug	28-24
enable acc call	28-24
enable acc call debug	28-24
purge acc	28-25

	purge acc script	28-25
	set acc call	28-26
	set acc call asyn	28-28
	set acc script	28-29
	show acc	28-31
	show acc call	28-32
	show acc domainname	28-36
	show acc script	28-36
CHAPTER 29	Generic Routing Encapsulation (GRE)	
	Introduction	29-2
	GRE on the Router	29-3
	Configuration Examples	29-5
	A Basic GRE Configuration	29-5
	A Multi-Point GRE Configuration	29-6
	Command Reference	29-10
	add gre	29-10
	add gre tunnel	29-12
	delete gre	29-13
	delete gre tunnel	29-13
	disable gre	29-14
	disable gre debug	29-14
	enable gre	29-14
	enable gre debug	29-15
	purge gre	29-15
	reset gre	29-16
	set gre	29-16
	set gre tunnel	29-18
	show gre	29-18
	show gre general	29-20
	show gre tunnel	29-21
CHAPTER 30	Trigger Facility	
	Introduction	30-2
	Defining Triggers	30-3
	Configuration Example	30-4
	Command Reference	30-5
	activate trigger	30-5
	add trigger	30-6
	create trigger	30-7
	delete trigger	30-13
	destroy trigger	30-14
	disable trigger	30-14
	enable trigger	30-15
	purge trigger	30-15
	set trigger	30-16
	show trigger	30-21
CHAPTER 31	AppleTalk	
	Introduction	31-3
	AppleTalk Protocol Architecture	31-3
	AppleTalk Nodes and Networks	31-3
	LocalTalk	31-4
	EtherTalk and TokenTalk	31-5
	AppleTalk Address Resolution Protocol (AARP)	31-6
	Address Translation	31-6
	Dynamic Assignment of Protocol Addresses	31-7

Datagram Delivery Protocol	31-7
Routing Table Maintenance Protocol (RTMP)	31-8
Name Binding Protocol (NBP)	31-9
Zone Information Protocol (ZIP)	31-11
AppleTalk on the Router	31-11
AppleTalk Filtering	31-12
DDP packet filtering	31-13
RTMP or Routing Update filtering	31-14
Zone Filtering	31-15
AppleTalk Dial-On-Demand	31-16
Extended Ping for AppleTalk	31-17
Configuration Example	31-17
Command Reference	31-21
add apple circuit	31-22
add apple dlci	31-23
add apple packetfilter	31-24
add apple port	31-26
add apple route	31-29
add apple routefilter	31-30
add apple zone	31-31
add apple zonefilter	31-32
delete apple circuit	31-33
delete apple dlci	31-34
delete apple packetfilter	31-35
delete apple port	31-35
delete apple route	31-36
delete apple routefilter	31-36
delete apple zone	31-37
delete apple zonefilter	31-38
disable apple	31-38
disable apple debug	31-39
enable apple	31-39
enable apple debug	31-39
purge apple	31-40
reset apple	31-40
set apple packetfilter	31-41
set apple port	31-43
set apple routeconvert	31-45
set apple routefilter	31-46
set apple zone	31-47
set apple zonefilter	31-48
show apple	31-49
show apple aarp	31-50
show apple circuit	31-51
show apple counter	31-52
show apple dlci	31-58
show apple packetfilter	31-59
show apple port	31-61
show apple route	31-63
show apple routefilter	31-64
show apple zone	31-65
show apple zonefilter	31-66

CHAPTER 32 Time Division Multiplexing (TDM)

Introduction	32-2
E1/T1 Time Division Multiplexing	32-3
Static E1/T1 TDM Versus ISDN Calling	32-4
BRI Time Division Multiplexing	32-5

Configuration Examples	32-5
Configuring static E1/T1 TDM on a PRI	32-5
Configuring TDM on a BRI	32-7
Command Reference	32-7
add tdm	32-8
create tdm	32-9
delete tdm	32-10
destroy tdm	32-11
purge tdm	32-11
show tdm	32-12
CHAPTER 33 Logging Facility	
Introduction	33-2
Format of Log Messages	33-3
Secure Router Log Protocol (SRLP)	33-4
Net Manage Message Protocol	33-4
Processing Log Messages	33-4
Output Definitions and Message Filters	33-5
Destinations	33-6
Configuring Output Definitions	33-8
Configuring Message Filters	33-8
Configuration Example	33-9
Command Reference	33-12
add log output	33-12
add log receive	33-15
create log output	33-17
delete log output	33-21
delete log receive	33-21
destroy log output	33-22
disable log	33-22
disable log generation	33-22
disable log output	33-23
disable log reception	33-23
enable log	33-24
enable log generation	33-24
enable log output	33-24
enable log reception	33-25
flush log output	33-25
purge log	33-26
set log output	33-26
set log receive	33-32
set log utcoffset	33-33
show log	33-34
show log counter	33-40
show log output	33-42
show log queue	33-45
show log receive	33-46
show log status	33-47
CHAPTER 34 Scripting	
Introduction	34-2
Creating Scripts	34-2
Using Script Commands	34-3
Using the Built-In Text Editor	34-3
Loading from a TFTP Server	34-3
Loading from an Asynchronous Port	34-4
Using Scripts	34-4
Script Parameters	34-4

Script Control Structures	34-5
Command Reference	34-6
activate script	34-6
add script	34-7
deactivate script	34-8
delete script	34-9
if..then..else..endif	34-9
set script	34-11
show script	34-12
wait	34-14
 CHAPTER 35 Dynamic Host Configuration Protocol (DHCP)	
Introduction	35-2
Configuring the DHCP Server	35-2
BOOTP Relay Agents	35-3
Configuring the DHCP Client	35-4
DHC Files	35-4
Configuration Example	35-4
Command Reference	35-5
add dhcp policy	35-5
add dhcp range	35-11
create dhcp policy	35-11
create dhcp range	35-12
delete dhcp policy	35-13
delete dhcp range	35-17
destroy dhcp policy	35-18
destroy dhcp range	35-18
disable dhcp	35-19
enable dhcp	35-19
set dhcp	35-20
set dhcp policy	35-21
set dhcp range	35-26
show dhcp	35-27
show dhcp client	35-28
show dhcp policy	35-30
show dhcp range	35-31
 CHAPTER 36 Dynamic Host Configuration Protocol for IPv6 (DHCP6)	
Introduction	36-2
DHCP for IPv6	36-2
DHCP6 Messages	36-3
DHCP Unique Identifier (DUID)	36-3
Identity Associations	36-3
Configuring DHCP6 Servers	36-4
Configuring DHCP6 Clients	36-5
DHCP6 Message Authentication	36-5
Rapid Commit	36-6
Configuration Examples	36-7
Address Assignment	36-7
Prefix Delegation	36-8
Command Reference	36-10
add dhcp6 interface	36-10
add dhcp6 key	36-11
add dhcp6 policy	36-12
add dhcp6 range	36-13
create dhcp6 policy	36-14
create dhcp6 range	36-15
delete dhcp6 interface	36-16

delete dhcp6 key	36-16
delete dhcp6 policy	36-17
delete dhcp6 range	36-18
destroy dhcp6 policy	36-18
destroy dhcp6 range	36-19
disable dhcp6	36-19
disable dhcp6 debug	36-19
disable dhcp6 rapid	36-20
enable dhcp6	36-20
enable dhcp6 debug	36-20
enable dhcp6 rapid	36-21
set dhcp6 key	36-21
set dhcp6 policy	36-22
show dhcp6	36-23
show dhcp6 client	36-24
show dhcp6 counter	36-26
show dhcp6 interface	36-29
show dhcp6 key	36-30
show dhcp6 policy	36-31
show dhcp6 range	36-32
show dhcp6 server	36-34

CHAPTER 37 **Layer Two Tunneling Protocol (L2TP)**

Introduction	37-2
Overview of L2TP	37-2
L2TP on the Router	37-3
Configuration Examples	37-6
Inter-Router Tunnels	37-6
Simple Dial-In System	37-8
Configure L2TP to tunnel PPPoE sessions	37-10
Command Reference	37-12
activate l2tp call	37-12
add l2tp call	37-13
add l2tp ip	37-15
add l2tp password	37-16
add l2tp user	37-16
deactivate l2tp call	37-18
delete l2tp call	37-19
delete l2tp ip	37-19
delete l2tp password	37-20
delete l2tp user	37-20
disable l2tp	37-21
disable l2tp debug	37-21
disable l2tp server	37-22
enable l2tp	37-22
enable l2tp debug	37-23
enable l2tp server	37-24
set l2tp call	37-24
set l2tp checksum	37-26
set l2tp filter	37-26
set l2tp password	37-27
set l2tp user	37-27
show l2tp	37-29
show l2tp call	37-33
show l2tp ip	37-35
show l2tp tunnel	37-36
show l2tp user	37-44

CHAPTER 38 **Simple Network Management Protocol (SNMP)**

Introduction	38-3
Network Management Framework	38-3
Structure of Management Information	38-5
Names	38-6
Instances	38-6
Syntax	38-7
Access	38-7
Status	38-8
Description	38-8
The SNMP Protocol	38-8
SNMP Versions	38-9
SNMP Messages	38-9
Polling versus Event Notification	38-9
Message Format for SNMPv1 and SNMPv2c	38-10
SNMP Communities (Version v1 and v2c)	38-11
SNMPv3 Entities	38-12
SNMPv3 Message Protocol Format	38-13
SNMPv1 and SNMPv2c on the Router	38-14
SNMP MIB Views for SNMPv1 and SNMPv2c	38-15
SNMP Communities	38-15
Configuration Example (SNMPv1 and v2)	38-18
SNMPv3 on the Router	38-19
SNMP MIB Views for SNMPv3	38-20
SNMP Defined MIB Names	38-20
SNMP Groups	38-21
SNMP Users	38-21
SNMP Target Addresses	38-21
SNMP Target Params	38-21
Configuration Example (SNMPv3)	38-22
Command Reference	38-23
add snmp community	38-23
add snmp group	38-24
add snmp targetaddr	38-26
add snmp targetparams	38-27
add snmp user	38-28
add snmp view	38-29
create snmp community	38-30
delete snmp community	38-31
delete snmp group	38-32
delete snmp targetaddr	38-32
delete snmp targetparams	38-33
delete snmp user	38-33
delete snmp view	38-34
destroy snmp community	38-35
disable snmp	38-35
disable snmp authenticate_trap	38-35
disable snmp community	38-36
enable snmp	38-36
enable snmp authenticate_trap	38-37
enable snmp community	38-37
purge snmp	38-38
set snmp community	38-38
set snmp engineid	38-39
set snmp group	38-40
set snmp local	38-40
set snmp targetaddr	38-41
set snmp targetparams	38-42
set snmp user	38-43

show snmp	38-44
show snmp community	38-48
show snmp group	38-49
show snmp targetaddr	38-50
show snmp targetparams	38-51
show snmp user	38-52
show snmp view	38-53

CHAPTER 39 Transaction Packet Assembler Disassembler (TPAD)

Introduction	39-2
The TPAD Protocol	39-4
TPAD on the Router	39-5
TPAD Chip and PIN Authentication	39-7
The Hayes Standard AT Command Set on the Router	39-8
TPAD Fast Disconnect	39-9
Configuration Examples	39-10
Configuring X.25 Interfaces	39-10
Creating TPAD Instances	39-12
Troubleshooting TPAD	39-14
Command Reference	39-16
add tpad	39-17
create tpad	39-17
delete tpad	39-19
destroy tpad	39-20
disable tpad	39-21
disable tpad debug	39-21
enable tpad	39-22
enable tpad debug	39-22
reset tpad	39-23
set tpad	39-23
show tpad	39-25
show tpad connections	39-27
show tpad counter	39-28

CHAPTER 40 Resource Reservation Protocol (RSVP)

Introduction	40-2
Resource Reservation Protocol (RSVP)	40-2
RSVP on the Router	40-5
RSVP Proxy Agent	40-6
Command Reference	40-8
create rsvp proxy	40-8
destroy rsvp proxy	40-11
disable rsvp	40-11
disable rsvp debug	40-12
disable rsvp interface	40-12
disable rsvp proxy	40-13
enable rsvp	40-14
enable rsvp debug	40-14
enable rsvp interface	40-15
enable rsvp proxy	40-15
reset rsvp proxy	40-16
set rsvp interface	40-17
set rsvp proxy	40-18
show rsvp	40-19
show rsvp counter	40-21
show rsvp interface	40-23
show rsvp path	40-24
show rsvp proxy	40-25
show rsvp proxy counter	40-27
show rsvp resv	40-28

CHAPTER 41 **Firewall**

Introduction	41-3
Firewall Technologies	41-3
Policies	41-5
Rules	41-6
Multicast Packet Handling	41-9
Access Lists	41-9
List Files	41-9
RADIUS Servers	41-10
Network Address Translation (NAT)	41-11
Interface-based NAT	41-11
Rule-based NAT	41-12
Adding and Removing a NAT Translation	41-12
Ethernet Interfaces	41-13
Web Redirection with Reverse NAT Rules	41-15
UPnP	41-16
Dynamic Interfaces	41-16
Dynamic Interface Templates	41-16
Configuring Dynamic Interfaces	41-17
Firewall SMTP Proxy (Application Gateway)	41-18
Interaction Between the SMTP Proxy and Firewall Rules	41-18
Protecting the Email System	41-18
Email Relaying	41-19
Firewall HTTP Application Gateway (Proxy)	41-19
Firewall HTTP Proxies and Firewall Policies	41-19
HTTP Filters	41-20
Logging	41-20
Disabling the TCP Set-up Proxy	41-21
Enabling the Secure Shell Server	41-21
Monitoring Firewall Activity	41-22
Notifications	41-22
Debugging	41-22
Event Triggers	41-22
Logging	41-23
Enhanced Packet Fragment Handling	41-26
Accounting	41-26
Configuration Examples	41-27
Minimum Configuration for a Small Office	41-27
A Firewall with an ISP-Assigned Internet Address	41-27
A Firewall with a Single Global Internet Address	41-28
Allowing Access to a WWW Server	41-29
A Firewall with TCP Setup Proxy Disabled for File Sharing	41-30
Command Reference	41-31
add firewall policy apprule	41-31
add firewall policy dynamic	41-33
add firewall policy httpfilter	41-33
add firewall policy interface	41-36
add firewall policy list	41-38
add firewall policy nat	41-39
add firewall policy proxy	41-41
add firewall policy rule	41-43
add firewall policy spamsources	41-50
create firewall policy	41-51
create firewall policy dynamic	41-51
delete firewall policy apprule	41-52
delete firewall policy dynamic	41-52
delete firewall policy httpfilter	41-53
delete firewall policy interface	41-54
delete firewall policy list	41-55

delete firewall policy nat	41-55
delete firewall policy proxy	41-57
delete firewall policy rule	41-58
delete firewall policy spamsources	41-58
delete firewall session	41-59
destroy firewall policy	41-60
destroy firewall policy dynamic	41-60
disable firewall	41-61
disable firewall notify	41-61
disable firewall policy	41-62
disable firewall policy httpcookies	41-64
disable firewall policy identproxy	41-64
disable firewall policy smtprelay	41-65
disable firewall policy tcpsetupproxy	41-65
enable firewall	41-66
enable firewall notify	41-66
enable firewall policy	41-67
enable firewall policy httpcookies	41-70
enable firewall policy identproxy	41-70
enable firewall policy smtprelay	41-71
enable firewall policy tcpsetupproxy	41-71
set firewall maxfragment	41-72
set firewall policy	41-73
set firewall policy attack	41-74
set firewall policy rule	41-76
set firewall policy smtpdomain	41-79
show firewall	41-80
show firewall accounting	41-81
show firewall arp	41-83
show firewall event	41-84
show firewall policy	41-86
show firewall policy attack	41-100
show firewall session	41-101

CHAPTER 42 UPnP

Introduction	42-2
Overview of UPnP	42-3
UPnP Architecture	42-3
UPnP Networking Phases	42-5
UPnP and the Firewall	42-6
UPnP on the router	42-6
Additional security configuration	42-8
Configuration Example	42-9
Command Reference	42-11
disable upnp	42-11
disable upnp action	42-12
disable upnp l4port	42-13
enable upnp	42-13
enable upnp action	42-14
enable upnp l4port	42-14
show upnp	42-15
show upnp counter	42-16
show upnp interface	42-18
show upnp interface subscriptions	42-21

CHAPTER 43 Secure Shell

Introduction	43-2
Secure Shell on the Router	43-2
Configuring Secure Shell	43-3
Configuration Example	43-5
Command Reference	43-9
add ssh user	43-9
delete ssh user	43-10
disable ssh server	43-11
disable ssh user	43-11
enable ssh server	43-12
enable ssh user	43-13
set ssh server	43-13
set ssh user	43-15
show ssh	43-16
show ssh sessions	43-23
show ssh user	43-24
ssh	43-25

CHAPTER 44 Link Compression and Encryption

Introduction	44-2
Overview	44-2
Link Compression	44-3
PPP	44-3
Frame Relay	44-4
X.25	44-5
Link Encryption	44-5
Star Key Management	44-5
PPP	44-10
Frame Relay	44-11
Command Reference	44-11
create star	44-12
destroy star	44-13
disable star debugging	44-13
enable star debugging	44-14
enable star mkttransfer	44-14
set star	44-15
show star	44-16
show star counter	44-18
show star mkttransfer log	44-23
show star netkey	44-24

CHAPTER 45 IP Security (IPsec)

Introduction	45-3
IP Security (IPsec)	45-4
Security Protocols and Modes	45-4
Compression Protocol	45-5
Security Associations (SA)	45-5
ISAKMP/IKE	45-6
ISAKMP	45-6
IKE	45-10
IPsec on the Router	45-12
Security Policy Database (SPD)	45-13
SA Bundles	45-16
Security through Key Management	45-16
Dynamic IP Addresses	45-17
IPsec Support for IPv6	45-18
IPsec over UDP	45-19
Pre-IPsec Security Associations	45-20

ISAKMP/IKE on the Router	45-21
ISAKMP Policies	45-21
ISAKMP Exchanges	45-23
ISAKMP Security Associations (SA)	45-23
ISAKMP Heartbeats	45-24
IPsec NAT-Traversal	45-25
Basic NAT-T Operations	45-25
NAT-T on the Router	45-26
Pre-IPsec Security Associations	45-28
Configuration Examples	45-29
Setting Security	45-30
VPN-only with details about ISAKMP/IKE key management	45-31
VPN with NAT-Traversal	45-35
Troubleshooting IPsec	45-42
IPsec	45-42
ISAKMP	45-43
Command Reference	45-45
activate ipsec convertoldsa	45-45
add sa member	45-46
create ipsec bundlespecification	45-46
create ipsec policy	45-48
create ipsec saspecification	45-52
create isakmp policy	45-53
create sa	45-58
delete sa member	45-59
destroy ipsec bundlespecification	45-59
destroy ipsec policy	45-60
destroy ipsec saspecification	45-61
destroy isakmp policy	45-61
destroy sa	45-62
disable ipsec	45-62
disable ipsec oldsa	45-63
disable ipsec policy debug	45-63
disable isakmp	45-65
disable isakmp debug	45-65
disable sa debug	45-66
enable ipsec	45-66
enable ipsec oldsa	45-67
enable ipsec policy debug	45-67
enable isakmp	45-69
enable isakmp debug	45-70
enable sa debug	45-71
purge ipsec	45-71
reset ipsec counter	45-72
reset ipsec policy counter	45-72
reset ipsec sa counter	45-73
reset isakmp counters	45-73
set ipsec bundlespecification	45-74
set ipsec policy	45-75
set ipsec saspecification	45-78
set ipsec udpport	45-80
set isakmp policy	45-80
set sa	45-85
show ipsec	45-86
show ipsec bundlespecification	45-86
show ipsec counter	45-88
show ipsec policy	45-105
show ipsec sa	45-113
show ipsec saspecification	45-120

show isakmp	45-122
show isakmp counters	45-123
show isakmp exchange	45-151
show isakmp policy	45-159
show isakmp sa	45-162
show sa	45-167
show sa counter	45-170
show sa user	45-175

CHAPTER 46 **Public Key Infrastructure (PKI)**

Introduction	46-2
Overview of PKI	46-2
Public Keys	46-2
Certificates	46-3
Elements of a Public Key Infrastructure	46-4
Certificate Validation	46-5
Certificate Revocation Lists (CRLs)	46-6
PKI on the Router	46-6
Certificate Retrieval and Storage	46-6
Certificate Validation	46-8
Certificate Revocation Lists	46-8
Requesting a Certificate	46-9
Global PKI parameters	46-10
Configuration Examples	46-11
Manual Enrollment	46-11
Automatic Enrollment with CMP	46-13
Command Reference	46-15
add pki certificate	46-15
add pki crl	46-16
add pki ldaprepository	46-17
create pki certificate	46-18
create pki enrollmentrequest	46-19
create pki keyupdaterequest	46-20
delete pki certificate	46-21
delete pki crl	46-22
delete pki ldaprepository	46-22
destroy pki enrollmentrequest	46-23
destroy pki keyupdaterequest	46-23
disable pki debug	46-24
enable pki debug	46-24
purge pki	46-25
set pki	46-26
set pki certificate	46-27
set pki crl	46-27
set pki ldaprepository	46-28
show pki	46-29
show pki certificate	46-36
show pki crl	46-39
show pki enrollmentrequest	46-42
show pki keyupdaterequest	46-43
show pki ldaprepository	46-45

CHAPTER 47 **Virtual Router Redundancy Protocol (VRRP)**

Introduction	47-2
Virtual Router Redundancy Protocol	47-2
Interface Monitoring	47-3
Port Monitoring	47-4
Configuring VRRP	47-4

Adopting the VRRP IP Address	47-6
Triggers	47-8
Configuration Example	47-9
Preferred master with a backup router	47-9
Authenticated virtual router with no preferred master	47-10
Command Reference	47-11
add vrrp	47-11
add vrrp monitoredinterface	47-12
create vrrp	47-13
delete vrrp	47-15
delete vrrp monitoredinterface	47-16
destroy vrrp	47-17
disable vrrp	47-17
disable vrrp debug	47-18
enable vrrp	47-18
enable vrrp debug	47-19
set vrrp	47-19
show vrrp	47-21
CHAPTER 48 Open Systems Interconnection (OSI)	
Introduction	48-2
ISO NSAP (Network Service Access Point) Addresses	48-2
ISO on the Router	48-4
Mandatory CLNS Standards	48-4
Optional Sections of CLNS Standards	48-5
Mandatory ESIS Standards	48-6
Optional Sections of ESIS Standards	48-6
Mandatory ISIS Standards	48-6
Optional Sections of ISIS Standards	48-7
Layer 2 protocols supporting CLNS	48-7
CLNS circuits over dial-up PPP interfaces	48-7
SNMP	48-7
Configuration Examples	48-8
Example 1: Two routers and one OSI area.	48-8
Example 2: Three virtual routers and three OSI areas.	48-10
Command Reference	48-12
add clns adjacency	48-12
add clns area	48-13
add clns circuit	48-13
add clns ra	48-16
delete clns adjacency	48-17
delete clns area	48-18
delete clns circuit	48-18
delete clns ra	48-19
disable clns circuit	48-19
disable clns debug	48-20
enable clns	48-20
enable clns circuit	48-21
enable clns debug	48-22
purge clns	48-23
reset clns	48-23
set clns	48-24
set clns circuit	48-25
set clns ra	48-27
show clns	48-28
show clns adjacency	48-28
show clns area	48-30
show clns circuit	48-31

show clns circuit counters	48-34
show clns counters	48-36
show clns detail	48-37
show clns ra	48-39
show clns route	48-40

CHAPTER 49 **Border Gateway Protocol version 4 (BGP-4)**

Introduction	49-3
Overview of BGP-4	49-3
BGP Operation	49-5
BGP Attributes	49-6
BGP Route Selection	49-8
Classless Inter-domain Routing (CIDR) and Aggregation	49-9
BGP Multi-Homing	49-10
BGP Route Filtering	49-12
Route Maps	49-13
AS Confederations	49-15
Triggers	49-16
How to Configure BGP Peers	49-18
How to Create a Basic BGP AS	49-18
How to Create BGP Peers Using Peer Templates	49-22
How to Modify BGP Peers (Without Templates)	49-23
How to Use a Template to Modify BGP Peers	49-24
How to Modify BGP Peers that Use a Template	49-25
How to Delete BGP Peers	49-25
How to Filter Routes for BGP	49-26
How to Configure AS Path Filters	49-26
How to Configure Prefix Filters	49-28
How to Configure Route Maps	49-29
How to Optimise BGP	49-35
How to Handle Spikes in Memory Use	49-35
How to Stop BGP from Overloading System Memory	49-36
How to Control Import of Static Routes	49-37
How to Set the IP Address By Which the Router Identifies Itself	49-38
Configuration Examples	49-39
Example One	49-39
Example Two	49-41
Example Three	49-41
Example Four	49-41
Example Five	49-42
Example Six	49-43
Example Seven	49-43
Example Eight	49-44
Command Reference	49-45
add bgp aggregate	49-46
add bgp confederationpeer	49-48
add bgp import	49-49
add bgp network	49-50
add bgp peer	49-51
add bgp peertemplate	49-57
add ip aspathlist	49-62
add ip communitylist	49-64
add ip prefixlist	49-66
add ip routemap	49-68
delete bgp aggregate	49-73
delete bgp confederationpeer	49-74
delete bgp import	49-75

delete bgp network	49-76
delete bgp peer	49-77
delete bgp peertemplate	49-77
delete ip aspathlist	49-78
delete ip communitylist	49-79
delete ip prefixlist	49-79
delete ip routemap	49-80
disable bgp autosoftupdate	49-81
disable bgp debug	49-82
disable bgp peer	49-83
enable bgp autosoftupdate	49-83
enable bgp debug	49-84
enable bgp peer	49-85
reset bgp peer	49-85
reset bgp peer soft	49-86
set bgp	49-87
set bgp aggregate	49-90
set bgp backoff	49-91
set bgp import	49-92
set bgp memlimit	49-93
set bgp peer	49-94
set bgp peertemplate	49-100
set ip autonomous	49-105
set ip routemap	49-106
show bgp	49-111
show bgp aggregate	49-113
show bgp confederation	49-114
show bgp backoff	49-115
show bgp import	49-117
show bgp memlimit	49-118
show bgp memlimit scan	49-119
show bgp network	49-121
show bgp peer	49-122
show bgp peertemplate	49-127
show bgp route	49-129
show ip aspathlist	49-131
show ip communitylist	49-132
show ip prefixlist	49-133
show ip routemap	49-135

CHAPTER 50 **Load Balancer**

Introduction	50-3
Load Balancer Overview	50-3
Load Balancer on the Router	50-5
TCP Virtual Balancer	50-5
Route-based Virtual Balancer	50-6
HTTP Virtual Balancer	50-7
SSL Load Balancer	50-8
Load Balancer and Firewall	50-9
Redundancy	50-10
Health Checks	50-12
Triggers	50-13
Configuration Example	50-17
Command Reference	50-20
add loadbalancer resource	50-20
add loadbalancer respool	50-21
add loadbalancer virtualbalancer	50-22
add loadbalancer virtualbalancer httperrorcode	50-25

delete loadbalancer resource	50-26
delete loadbalancer respool	50-27
delete loadbalancer virtualbalancer	50-27
delete loadbalancer virtualbalancer httperrorcode	50-29
disable loadbalancer	50-29
disable loadbalancer debug	50-30
disable loadbalancer healthpings	50-30
disable loadbalancer redundancy	50-31
disable loadbalancer resource	50-31
disable loadbalancer virtualbalancer	50-32
enable loadbalancer	50-33
enable loadbalancer debug	50-33
enable loadbalancer healthpings	50-34
enable loadbalancer redundancy	50-34
enable loadbalancer resource	50-35
enable loadbalancer virtualbalancer	50-36
reset loadbalancer	50-36
set loadbalancer	50-37
set loadbalancer redundancy	50-38
set loadbalancer resource	50-39
set loadbalancer respool	50-40
set loadbalancer virtualbalancer	50-41
show loadbalancer	50-43
show loadbalancer affinity	50-44
show loadbalancer connections	50-46
show loadbalancer redundancy	50-47
show loadbalancer resource	50-49
show loadbalancer respool	50-51
show loadbalancer virtualbalancer	50-53

CHAPTER 51 **Secure Sockets Layer (SSL)**

Introduction	51-2
SSL Operations	51-2
Phases	51-3
SSL on the Router	51-5
SSL and the Graphical User Interface	51-5
SSL and the load balancer	51-6
Configuration Example	51-6
Enable SSL on the Router's HTTP Server	51-6
Command Reference	51-8
disable ssl debug	51-8
enable ssl debug	51-9
set ssl	51-9
show ssl	51-10
show ssl sessions	51-19

CHAPTER 52 **Voice over IP (VoIP)**

Introduction	52-3
VoIP Overview	52-3
VoIP Benefits and Business Applications	52-4
VoIP FXS Interface Components	52-5
Ring Generation	52-5
Tone Generation	52-6
Port Gain	52-6
Port Impedance	52-6
Voice Activation and Silence Detection	52-6
Digit Collection	52-6

VoIP Protocols	52-7
H.323	52-7
Session Initiation Protocol (SIP)	52-12
VoIP Engines	52-17
Downloading VoIP Firmware	52-19
Configuration Examples	52-21
Using H.323 and no gatekeeper	52-21
Using H.323 and a gatekeeper	52-23
Using a SIP server	52-24
Command Reference	52-26
create h323	52-26
create h323 entry	52-27
create sip	52-28
destroy h323	52-30
destroy h323 entry	52-30
destroy sip	52-31
disable voip	52-31
disable voip debug	52-32
enable voip protocol	52-32
enable voip debug	52-33
reset voip	52-34
set h323	52-34
set h323 entry	52-35
set h323 gateway	52-36
set sip	52-37
set sip gateway	52-39
set voip	52-39
set voip ap	52-40
set voip bootcode	52-42
set voip file	52-42
set voip phone	52-43
set voip public interface	52-50
show h323	52-51
show h323 entry	52-52
show h323 gateway	52-53
show sip	52-54
show sip gateway	52-55
show voip	52-55
show voip ap	52-57
show voip counter engine	52-58
show voip instance	52-61
show voip load	52-61
show voip phone	52-62

APPENDIX A Messages

Introduction	A-3
Message Descriptions	A-4
smmm001–smmm255: Global Messages	A-4
s002256–s002999: Frame Relay	A-12
s003256–s003999: Point-to-Point Protocol	A-15
s004256–s004999: AppleTalk	A-19
s005256–s005999: Internet Protocol (IP)	A-23
s006256–s006999: Novell IPX	A-34
s007256–s007999: SYN Driver	A-37
s008256–s008999: DECnet	A-38
s013256–s013999: X.25 Layer 3 (DCE)	A-38
s014256–s014999: Q.931	A-40
s017256–s017999: LAPB	A-42

s018256–s018999: TEST Module	A-42
s019256–s019999: LAPD	A-45
s020256–s020999: Synchronous Tunnelling (STT)	A-48
s021256–s021999: Stream Printing	A-49
s022256–s022999: TCP	A-49
s023256–s023999: Ethernet Driver	A-49
s024256–s024999: Permanent Assignments	A-50
s026256–s026999: LPD Server	A-51
s027256–s027999: Bridging	A-52
s030256–s030999: X.25 Layer 3 (DTE)	A-56
s031256–s031999: FLASH Driver	A-58
s033256–s033999: TELNET	A-59
s034256–s034999: System	A-60
s035256–s035999: Command Processor	A-62
s036256–s036999: TTY	A-62
s037256–s037999: ISDN Call Control	A-65
s038256–s038999: MIOX	A-68
s039256–s039999: BOOTP	A-70
s040256–s040999: Network Time Protocol (NTP)	A-70
s041256–s041999: BRI Driver	A-71
s042256–s042999: PRI Driver	A-72
s043256–s043999: PORT Driver	A-74
s045256–s045999: User Authentication Facility	A-77
s046256–s046999: Asynchronous Call Control	A-81
s048256–s048999: LOADER	A-85
s049256–s049999: INSTALL	A-88
s050256–s050999: Open Shortest Path First (OSPF)	A-91
s051256–s051999: Radius	A-95
s052256–s052999: Generic Routing Encapsulation (GRE)	A-96
s053256–s053999: Trigger Facility	A-97
s054256–s054999: Scripting	A-99
s055256–s055999: Time Division Multiplexing (TDM)	A-100
s056256–s056999: File Subsystem	A-102
s057256–s057999: Logging Facility	A-104
s058256–s058999: PING	A-107
s059256–s059999: Simple Network Management Protocol (SNMP)	A-109
s062256–s062999: Security Associations	A-112
s066256–s066999: Internet Protocol version 6 (IPv6)	A-113
s067256–s067999: Layer 2 Tunnelling Protocol (L2TP)	A-117
s068256–s068999: Asynchronous Transfer Mode (ATM)	A-117
s070256–s070999: Dynamic Host Configuration Protocol (DHCP)	A-121
s073256–s073999: Encryption	A-122
s074256–s074999: Star Key Management	A-124
s075256–s075999: Secure Shell	A-125
s076256–s076999: Resource Reservation Protocol (RSVP)	A-126
s077256–s077999: Firewall	A-126
s079256–s079999: Transaction Packet Assembler	
Disassembler (TPAD)	A-130
s081256–s081999: IP Security (IPsec)	A-131
s082256–s082999: ISAKMP/IKE	A-137
s083256–s083999: Finger	A-138
s084256–s084999: HTTP	A-138
s088256–s088999: Virtual Router Redundancy Protocol (VRRP)	A-139
s089256–s089999: VLANs	A-140
s092256–s092999: Spanning Tree Protocol (STP)	A-151
s093256–s093999: GUI	A-154
s094256–s094999: Open Systems Interconnection (OSI)	A-155
s095256–s095999: Public Key Infrastructure (PKI)	A-157
s096256–s096999: Lightweight Directory Access Protocol (LDAP)	A-158

s097256–s097999: Protocol Independent Multicast (PIM)	A-162
s100256–s100999: Generic Classifier	A-165
s102256–s102999: Switch Driver	A-166
s103256–s103999: Border Gateway Protocol version 4 (BGP-4)	A-169
s104256–s104999: Load Balancer	A-173
s110256–s110999: Voice over IP (VoIP)	A-177
s112256–s112999: S/Key	A-180
s113256–s113999: UPnP (Universal Plug and Play)	A-180
s117256–s117999: Dynamic Host Configuration Protocol version 6 (DHCP6)	A-181
s118256–s118999: Port Authentication	A-183
s121256–s121999: Asymmetric Digital Subscriber Line (ADSL)	A-185
s123256–s123999: Software Quality of Service	A-185

CHAPTER B **SNMP MIBs**

Introduction	B-2
Allied Telesyn Enterprise MIB	B-3
The Products Sub-tree	B-3
The AT Router Sub-tree	B-6
The Objects Group	B-7
The sysinfo Group	B-12
The arInterfaces Group	B-13
The Modules Group	B-14
MIB-II MIB	B-26
Implementation	B-27
IP Forwarding Table MIB	B-28
Implementation	B-28
Ethernet-like Interface Types MIB	B-29
Implementation	B-29
Bridge MIB	B-30
Implementation	B-31
ATM MIB	B-32
ADSL Line MIB	B-33
Implementation	B-33
Port Access Control MIB	B-35
Implementation	B-36
RMON MIB	B-37
Implementation	B-38
Frame Relay DTE MIB	B-39
Implementation	B-40
DS1, E1, DS2 and E2 Interface Types MIB	B-41
Implementation	B-41
Host Resources MIB	B-43
Implementation	B-44
SNMP v3 MIBs	B-46
Implementation	B-47
Border Gateway Protocol v4 (BGP-4) MIB	B-48
Implementation	B-49

APPENDIX C **Reference Tables**

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

Glossary

Index