Contents at a Glance

Introduction xvii

Part I Managing Routing 2

Chapter 1 Managing Your IP Address Space 4

Chapter 2 Deploying Interior Routing Protocols 38

Chapter 3 Managing Routing Protocols 62

Part II Managing Quality of Service 112

Chapter 4 Deploying Basic Quality of Service Features 114

Chapter 5 Deploying Advanced Quality of Service Features 144

Part III Managing Security 180

Chapter 6 Deploying Basic Security Services 182

Chapter 7 Advanced Security Services, Part I: IPsec 222

Chapter 8 Advanced Security Services, Part II: IOS Firewall Feature Set 284

Part IV Appendixes 310

Appendix A Obtaining IETF RFCs 312

Appendix B Retreiving Internet Drafts 316

Appendix C Common TCP and UDP Ports 320

Appendix D Password Recovery 324

Appendix E A Crash Course in Cisco IOS 330

Bibliography 376

Index 380

Table of Contents

Introduction xvii

Chapter 2 Deploying Interior Routing Protocols

A Brief Review of Internetworking

Part I Managing Routing	2
-------------------------	---

Part I Mai	naging Routing 2
Chapter 1	Managing Your IP Address Space 4
	Review of Traditional IP Addressing 6
	Subnetting a Classful Address Space 7 Major Nets and Subnet Masks 8 Classful Subnetting: An Example 11 Calculating the Number of Host Addresses in a Subnet 12 Finding Subnet Information, Given a Host Address and the Mask 1 Disadvantages of Subnetting 14 The Rules on Top and Bottom Subnets 14 Using Subnet-Zero to Get Around the Rules 15
	Subnetting with Variable Length Subnet Masks 16 Using VLSM for Address Space Efficiency: An Example 16 Final VLSM Results for Widget, Inc. 23
	Overview of Classless Addressing 24 Using VLSM Techniques with Classless Addressing 26 Routing Protocols and Classless Addressing 27
	Planning for Address Summarization 28
	Conserving Subnets with IP Unnumbered 29
	Scaling the Address Space with Network Address Translation Translating Private Addresses into Public Addresses 31 Configuring NAT 33
	Creating a Pool of Discontiguous Addresses 34 Configuring Static NAT 35 Special Applications and NAT 35 More Important Points on NAT 35
	Summary 36

38

39

	Deploying RIP 42 Directly Connected Networks 43 Configuring RIP 44 Verifying RIP Configuration 45
	Deploying IGRP 47 Configuring IGRP 48 Verifying IGRP Configuration 49
	Deploying Enhanced IGRP 50 Configuring EIGRP 51 Verifying EIGRP Configuration 52
	Deploying OSPF 54 Configuring OSPF 55 Verifying OSPF Configuration 59
	Summary 60
Chapter 3	Managing Routing Protocols 62
	Configuring Passive Interfaces 63
	Filtering Routing Updates 65
	Managing Redistribution 68 Configuring Redistribution—RIP and OSPF 70 Redistributing into IGRP and EIGRP 72 Understanding Administrative Distance 73 Controlling Redistribution Loops with Route Filters 76
	Resolving Issues with VLSM and Classful Routing Protocols 78
	Propagation of Default Routes 84 Originating a Default Route with RIP 85 Originating a Default Route with IGRP 86 Originating a Default Route with EIGRP 88 Originating a Default Route with OSPF 88 Default Routing and Classful Behavior 89
	Configuring Route Summarization 92 Understanding EIGRP Auto-Summarization 92 Configuring EIGRP Summarization 94 Configuring OSPF Summarization Between Areas 97 Configuring OSPF Summarization During Redistribution 98

	Deploying Policy Routing with Route Maps 99 Forwarding Traffic with Route Maps 100 Classifying Packets with Route Maps 107 Setting Next-Hop and Precedence in Tandem 109 Other Policy-Routing Commands 109 Summary 110	
Part II Mana	ging Quality of Service 112	
Chapter 4 D	eploying Basic Quality of Service Features 114	
	The Case for QoS 115	
	Queuing in a Router 117 First-In, First-Out Queuing 117 FIFO: An Example 119	
	Priority Queuing 120 Queuing and Classifying Packets with Priority Queuing 12 Priority Queuing Strategy 123 Configuring Priority Queuing 124 Verifying the Priority Queuing Configuration 125 Adjusting the Queue Sizes in Priority Queuing 125	:1
	Custom Queuing 126 Configuring Custom Queuing 129 Verifying the Custom Queuing Configuration 131 Adjusting the Queue Sizes in Custom Queuing 132	
	Understanding IP Precedence 133 Setting IP Precedence 133 QoS Benefits of IP Precedence 134 Diffserv Redefines IP Precedence 134	
	Weighted Fair Queuing 135 Configuring Weighted Fair Queuing 136 Fair Queuing in Action 137 Fair Queuing Versus FIFO 138 Weighting and IP Precedence 140 Weighted Fair Queuing on a Network 141	
	Summary 143	
Chapter 5 D	eploying Advanced Quality of Service Features 144	
	Resource Reservation Protocol 145	

RSVP Admission Control 146

RSVP Signaling Versus Bulk Data 148
The RSVP Signaling Process 149
RSVP and Weighted Fair Queuing 154
Configuring RSVP 155
Verifying RSVP Configuration 157
Configuring IOS as a Proxy for Path and Resv Messages 158
RSVP Scaling Considerations 161

Random Early Detection 161

Dynamics of Network Congestion and Tail Drops 162

Global Synchronization 163

TCP Slow Start 163

Ill Effects of Global Synchronization and TCP Slow Start 164

How RED Works 165

RED and IP Precedence (Weighted RED) 165

Configuring WRED 166

Verifying WRED Configuration 167

Committed Access Rate 168

Rate Policies 168

Configuring Cisco Express Forwarding 169

Configuring CAR 170

Validating CAR Configuration 173

Class-Based WFQ 173
Configuring CBWFQ 174
Verifying CBWFQ 177

Summary 178

Part III Managing Security 180

Chapter 6 Deploying Basic Security Services 182

Controlling Traffic with Access Control Lists 183
Filtering Traffic with Access Lists 184
Standard IP Access Lists 187
Important Points for Designing Access Lists 192
The Invisible Rule in Every Access List 193
Extended IP Access Lists 194
Access Lists for Combating Spoofing Attacks 200

Securing Access to the Router 202
Securing the Enable Mode of a Router 203
Securing Telnet Access 204
Securing Access to the Console Port 205

	Deploying Authentication, Authorization, and Accounting 207 Authentication, Authorization, and Accounting 207 Configuring Authentication for Network Access over PPP 210 Using the Default Authentication List 213 Configuring Authentication for Router Logins 214 The Local Username Database 215 Configuring Authorization 216 Configuring Accounting 216 Pointing the Router to the RADIUS or TACACS+ AAA Server 217
	Other IOS Commands for Basic Security 218 Disable TCP and UDP Small Servers 218 Disable IP Source Routing 219 Disable CDP on Public Links 219 Disable Directed Broadcasts on Interfaces 220
	Summary 220
Chapter 7	Advanced Security Services, Part I: IPsec 222
	IPsec Enables Virtual Private Networks 224
	Benefits of IPsec's Layer 3 Service 225
	Basic IPsec Security Concepts and Cryptography 226 Confidentiality (Encryption) 227 Integrity 233 Hashing Algorithms: Examples with Message Digest 5 234 Origin Authentication 236 Anti-Replay 238
	IPsec Concepts 239 Peers 239 Transform Sets 239 Security Associations 240 Transport and Tunnel Modes 241 Authentication Header and Encapsulating Security Payload 242
	Internet Key Exchange 244
	Tying All of the Pieces Together: A Comprehensive Example with IPsec and IKE 245
	Configuring IKE 246 Configuring IKE with Pre-Shared Keys 246 Configuring IKE with RSA Encryption 249 Configuring IKE with RSA Signatures and Digital Certificates 253 Additional Commands for IKE 260

Validating IKE Configuration 262 When Are IKE SAs Established? 262

Configuring IPsec 263 Crypto Maps 263

Crypto Map Configuration Overview 264

Configuring Crypto Access Lists 265

Crypto Access Lists: An Example 266

Configuring IPsec Transform Sets 269

Configuring and Applying Crypto Maps 270

When Are SAs Established? 272

Configuring IPsec SA Lifetimes 273

Configuring Perfect Forward Secrecy 274

Configuring Dynamic Crypto Maps 274

Tunnel Endpoint Discovery 276

Validating IPsec Configuration 277

Troubleshooting IPsec and IKE 278

Check Configurations and Show Commands 278

Enable Debugging and Clearing Existing SAs 279

Summary 281

Chapter 8 Advanced Security Services, Part II: IOS Firewall Feature Set 284

IOS Firewall Fundamentals 285

Defending the Perimeter Against Attacks 286

How Context-Based Access Control Works 287

Configuring CBAC 288

CBAC Example: A Basic Two-Port Firewall 288

Validating CBAC Configuration 292

Configuring CBAC Inspection of Other Applications 294

Adjusting CBAC Timers and Thresholds 296

Adjusting CBAC Session Timers 296

Overriding Global Timers with Inspection Rules 298

Adjusting CBAC Denial of Service Thresholds 298

Enabling Auditing of Sessions 300

CBAC with a Demilitarized Zone 300

Basic Security Commands for the Firewall Router 301

Configuring the Inspection Rule 302

Configuring the Private Network Interface 302

Configuring the DMZ Network Interface 303

Configuring the Internet Interface 304

Notes on CBAC Performance 305

Configuring Java Applet Blocking for Security 305

The IOS Intrusion Detection System 306 Configuring IDS 307 Additional Commands for IDS 308

Summary 309

Part IV Appendixes 310

Appendix A Obtaining IETF RFCs 312

Via the World Wide Web 313

Via FTP 314

Via E-Mail 314

Finding Current RFCs 314

Authoring RFCs 315

Appendix B Retrieving Internet Drafts 316

Via the World Wide Web 317

Via FTP 317

Via E-Mail 318

Authoring Internet Drafts 318

Appendix C Common TCP and UDP Ports 320

Appendix D Password Recovery 324

Recovering a Lost Password on Most Router Models 327

Recovering a Lost Password on Other Router Models 329

Appendix E A Crash Course in Cisco IOS 330

Connecting to the Router 331

Connect via Direct Serial Cable to the Console Port 331

Connect via Telnet over the IP Network 332

Connect via the AUX Port or Other Asynchronous Serial Port

Modes 332

User EXEC Mode 332

Privileged EXEC Mode (Enable Mode) 333

Global Configuration Mode 334 Interface Configuration Mode 334 Subinterface Configuration Mode 335 Line Configuration Mode Other Configuration Modes Context-Based Help, Navigation, and Line Editing 336 Context-Based Help 336 Navigation 337 339 Line Editing Common IOS Commands 339 Extended Ping Extended Traceroute 343 Common Configuration Tasks 345 The Setup Utility (Initial Configuration Dialog) Set the Enable Password 347 Set the Router's Hostname Make a Banner 347 Set the System Clock and Date 348 Set the Domain Name Set the Name Server(s) 348 Populate the Router's Local Host Table 348 Set SNMP Community Strings 348 Set SNMP Trap Hosts 349 Enable the Router to Send SNMP Traps 349 Point the Router to a Syslog Server Configure Timestamping of System and Debug Messages 349 Point the Router to a Network Time Protocol (NTP) Server 350 Set the Time Zone Set Daylight Saving Time Information 350 Configure a Static Route 351 351 Configure a Default Route Configure an IP Address on an Interface 352 Other Interface Configuration Tasks Configure the Location of the Boot Image 353 Retract (undo) Configuration Commands 354 Common Show Commands General Show Commands 354 Resource Show Commands 357 Interface Show Commands 360 Network Show Commands 364

366

Routing Show Commands

Using the Router as a Terminal Server (Communications Server) 368
Enabling IOS Web-Based Management 373

Bibliography 376

Index 380