



# Contents at a Glance

<b>Acknowledgments</b>	<b>xvii</b>
<b>Introduction</b>	<b>xix</b>
<b>Chapter 1 Networking Overview</b>	<b>1</b>
<b>Chapter 2 Routing Basics</b>	<b>69</b>
<b>Chapter 3 Static Routing</b>	<b>89</b>
<b>Chapter 4 Dynamic Routing</b>	<b>103</b>
<b>Chapter 5 RIP</b>	<b>137</b>
<b>Chapter 6 IGRP</b>	<b>167</b>
<b>Chapter 7 EIGRP</b>	<b>185</b>
<b>Chapter 8 OSPF</b>	<b>221</b>
<b>Chapter 9 External Routing Protocols in Brief</b>	<b>343</b>
<b>Chapter 10 Redistribution and Default Routing</b>	<b>361</b>
<b>Appendix A Where Do You Go From Here?</b>	<b>379</b>
<b>Appendix B Recommended Reading</b>	<b>381</b>
<b>Appendix C RFCs Related to Routing</b>	<b>383</b>
<b>Appendix D Web References</b>	<b>387</b>
<b>Appendix E Administrative Distance Table</b>	<b>389</b>
<b>Appendix F Quick-and-Dirty Subnetting—No Calculator</b>	<b>391</b>
<b>Appendix G Subnetting Helper Sheet</b>	<b>393</b>
<b>Index</b>	<b>395</b>





# Contents

<b>Acknowledgments</b>	<b>xvii</b>
<b>Introduction</b>	<b>xix</b>
<b>Chapter 1 Networking Overview</b>	<b>1</b>
Overview	1
OSI Network Model	2
The Conundrum of Explaining the OSI Model	2
Mother of All OSI Model Explanations?	3
Anatomy of a Data Communication Session	3
The Way Things Used to Be	5
Explanation of OSI Layers	6
Another Mail Analogy	12
Encapsulation	13
TCP/IP Model	15
Networking Equipment	15
Packet Forwarding	16
Repeaters—Layer 1, Physical	16
Hubs—Layer 1, Physical	16
Bridges—Layer 2, Data-Link	17
Switches—Layer 2, Data-Link	18
Routers—Layer 3, Network	19
Layer 3 Switches	23
CSU/DSUs (TSU)	23
TCP/IP Review	24
IP Addressing	24
Ports and Sockets	56
Important Protocols Related to Routing	59
Notes	67

<b>Chapter 2</b>	<b>Routing Basics</b>	<b>69</b>
	Overview	69
	What Is Routing?	70
	Routing Begins at Home—The Workstation’s Route Table	71
	Row 1—Default Gateway	71
	Row 2—Loopback Address	73
	Row 3—Local Subnet Address	74
	Row 4—IP Address of Host	75
	Rows 5, 6, and 7—Broadcast Information	75
	Anatomy of a Routed Packet	76
	Track a Packet—Source and Destination on the Same Network	76
	Track a Packet—Source and Destination on Different Networks—One Router	78
	Track a Packet—Source and Destination on Different Networks—Multiple Routers	80
	Anatomy of a Route Table	81
	Key Concept for Understanding Route Tables	82
	Populating Route Tables	83
	Routing Metrics	84
	Administrative Distance	84
	Summary	86
	Notes	88
<b>Chapter 3</b>	<b>Static Routing</b>	<b>89</b>
	Overview	89
	What Is Static Routing?	90
	When to Use Static Routes	90
	Configuring Static Routes on a Router	91
	Example with a Small Routed Network	91
	Static Routes on a Workstation	98
	Floating Static Routes	100
	Propagating Static Routes	101
	Summary	101
	Notes	101
<b>Chapter 4</b>	<b>Dynamic Routing</b>	<b>103</b>
	Overview	103
	The Need for an Automated Routing Solution	104
	What Is a Routing Protocol?	105
	Considerations for Designing Routing Protocols	106
	Metrics of Routing Protocols	107
	Categorizing Dynamic Routing Protocols	108
	Interior versus Exterior Routing Protocols	108
	Distance Vector versus Link-State	109
	Singlepath versus Multipath	117
	Broadcast versus Multicast	117

Flat versus Hierarchical	118
Classful versus Classless	118
Route Summarization	119
Network Example 1	121
Network Example 2	124
Network Example 3	127
Network Example 4	132
Summary	134
Notes	135
<b>Chapter 5    RIP</b>	<b>137</b>
Overview	137
Advantages of Using RIP	138
Disadvantages of Using RIP	138
RIP Background	139
RIP Versions	139
RIPv2 Improvements	140
How RIP Works	140
Advertising Routes	140
Learning Routes	141
Information that RIP Tracks About a Route	141
A Look at How Route Tables Are Populated by RIP	142
RIP's Achilles Heel	145
RIP Timers that Contribute to Slow Convergence	145
How RIP Defends Itself Against the Dreaded Routing Loop	146
Anatomy of a Routing Loop	146
Measures to Prevent Routing Loops	149
Load Balancing	153
Default Routing	153
Redistribution	153
Command Reference—RIP	154
Initial Configuration	154
Common RIP Commands	159
Show Commands for RIP	163
Troubleshooting Commands	164
Notes	165
<b>Chapter 6    IGRP</b>	<b>167</b>
Overview	167
Advantages of Using IGRP	168
Disadvantages to Using IGRP	168
IGRP Background	169
How IGRP Works	170
IGRP Timers	170
Split Horizon	171
Poison Reverse	171
IGRP Metrics	171

Autonomous Numbers	173
Load Balancing in IGRP	173
Default Routing	174
Redistribution	175
Route Summarization in IGRP	175
Command Reference—IGRP	175
Initial Configuration	176
Common IGRP Commands	180
Show Commands for IGRP	182
Troubleshooting Commands	183
Notes	183
<b>Chapter 7 EIGRP</b>	<b>185</b>
Overview	185
Advantages of Using EIGRP	186
Disadvantages of Using EIGRP	187
EIGRP Background	187
EIGRP Terminology	187
Neighbor	188
Neighbor Discovery and Recovery	188
Packet Types	188
Hold-Time	188
Neighbor Table	189
Topology Table	189
Route Table	189
Reliable Transport Protocol (RTP)	189
Retransmission Timeout (RTO)	189
Smooth Round Trip Time (SRRT)	189
Reported Distance (RD)	189
Feasible Distance (FD)	189
Feasibility Condition (FC)	190
Successor	190
Feasible Successor (FS)	190
Diffusing Update Algorithm (DUAL)	190
The DUAL Finite State Machine	190
Passive and Active Route States	191
Stuck in Active (SIA)	191
How EIGRP Works	191
EIGRP Architecture	191
Populating the Topology Table and Route Table	198
Stuck in Active (SIA) Routes	205
DUAL Prevents a Routing-Loop	206
Load Balancing	207
Default Routing	208
Redistribution	208
Route Summarization	208

Command Reference—EIGRP	208
Initial Configuration	209
Common EIGRP Commands	213
Show Commands for EIGRP	217
Troubleshooting Commands	218
Notes	219
<b>Chapter 8    OSPF</b>	<b>221</b>
Overview	221
Advantages of Using OSPF	222
Disadvantages of Using OSPF	223
OSPF Background	223
Explaining OSPF	224
Introduction to OSPF	224
How OSPF Works	225
OSPF Terminology	233
Important Networking Terminology	233
Important OSPF Terminology	234
Watch Out for the “Type” Trap	243
OSPF Operation, Part 1: The Building Blocks	245
OSPF and Network Types	245
OSPF Areas	251
OSPF Metrics and Population of the Route Table	284
Route Summarization in OSPF	291
Redistribution in OSPF	294
Default Routing in OSPF	295
Partitioned Areas	298
Virtual Links	300
The Options Field	300
OSPF Operation, Part 2: Tying It All Together	301
Designing OSPF Networks	301
Command Reference	309
Single Area Model	309
Multi-area Model—Standard Area	314
Other Common OSPF Commands	331
Notes	340
<b>Chapter 9    External Routing Protocols in Brief</b>	<b>343</b>
Overview	343
Internal versus External Routing Protocols	344
A Brief History of External Gateway Protocols	345
BGP—King of External Routing Protocols	346
BGP Background	346
When to Use BGP	347
Other Uses for BGP	348
How BGP Works	349

Sample BGP System	357
The Future of BGP	358
Notes	359
<b>Chapter 10 Redistribution and Default Routing</b>	<b>361</b>
Overview	361
Route Redistribution	362
The Need for Redistribution	363
Redistribution Issues	365
Default Routing	367
When to Use Default Routing	367
When Not to Use Default Routing	369
Configuring Default Routing	370
Notes	378
<b>Appendix A Where Do You Go From Here?</b>	<b>379</b>
<b>Appendix B Recommended Reading</b>	<b>381</b>
<b>Appendix C RFCs Related to Routing</b>	<b>383</b>
<b>Appendix D Web References</b>	<b>387</b>
<b>Appendix E Administrative Distance Table</b>	<b>389</b>
<b>Appendix F Quick-and-Dirty Subnetting—No Calculator</b>	<b>391</b>
<b>Appendix G Subnetting Helper Sheet</b>	<b>393</b>
<b>Index</b>	<b>395</b>