

Illustrated TCP/IP

by Matthew G. Naugle

Wiley Computer Publishing, John Wiley & Sons, Inc.

ISBN: 0471196568 Pub Date: 11/01/98

Acknowl edgments

Part One - Introduction to the TCP/IP Protocol

<u>Chapter 2 - TCP/IP and Other Protocols</u>

Chapter 3 - The Origins of TCP/IP

Chapter 4 - The World Wide Web

Chapter 5 - Internet, Intranets, and Extranets

<u>Chapter 6 - Who Governs the Internet?</u>

Chapter 7 - The Governing Bodies of the Internet

Chapter 8 - An Overall View of the Internet

<u>Chapter 9 - Internet Timeline</u>

Chapter 10 - Circuit and Packet Switching

Chapter 11 - TCP/IP Protocol Documents

Chapter 12 - Why Study the RFCs?

Chapter 13 - Submitting an RFC

Chapter 14 - RFC Updates

Chapter 15 - RFC Format

Chapter 16 - Other RFC Format Requirements

<u>Chapter 17 - Requirements in RFCs</u>

Chapter 18 - TCP/IP: The Protocols (covered in this book) and the OSI Model

Chapter 19 - The Protocol Suite, According to This Book

Chapter 20 - IP Overview

Chapter 21 - IGPs, EGPs, and Routing Protocols

Chapter 22 - Introduction to Routing Protocols (RIP)

<u>Chapter 23 - Introduction to Routing Protocols (OSPF)</u>

<u>Chapter 24 - Other IP-Related Protocols</u>

Chapter 25 - Introduction to Transport Layer Protocols

<u>Chapter 26 - Introduction to the TCP/IP Standard Applications</u>

<u>Chapter 27 - The Internet Protocol (IP)</u>

Chapter 28 - Connectionless, Best-Effort Delivery Service

Chapter 29 - Data Encapsul ation by Layer

<u>Chapter 30 - IPv4 Header</u>

<u>Chapter 31 - Header Length, Service Type, and Total Length Fields</u>

Chapter 32 - Fragmentation Chapter 33 - Time to Live (TTL) Chapter 34 - Protocol and Checksum Fields Chapter 35 - IP Options Field Chapter 36 - Source and Destination Address Fields Chapter 37 - The IP Address Scheme Chapter 38 - Classful Addressing - The Original Address Scheme Chapter 39 - IP Address Format Chapter 40 - Identifying a Class Chapter 41 - Class A Address Chapter 42 - Class B Address Chapter 43 - Class C Address Chapter 44 - Class D Address Chapter 45 - Classes A-D Review **Chapter 46 - Subnetting Chapter 47 - Reasons for Subnetting** Chapter 48 - Subnetting Examples (Classes A, B, and C) Chapter 49 - More Subnet Examples Chapter 50 - Physical and Logical Addresses Chapter 51 - Subnet Mask Template Chapter 52 - An Example Conversion Chapter 53 - Let's Try One Chapter 54 - Subnet Bits Chapter 55 - Subnet Restrictions Chapter 56 - Subnet Mask Decisions Chapter 57 - Assigning More Than One Address to an Interface Chapter 58 - Classful IP Address Review Chapter 59 - IP Address Restrictions Chapter 60 - Address Allocation (The Internet Registry)

Part Two - The Protocol Suite of TCP/IP

<u>Chapter 61 - Address Resolution Protocol (ARP)</u>

Chapter 62 - ARP Packet Format

Chapter 63 - ARP Operation

<u>Chapter 64 - Rules for ARP</u>

<u>Chapter 65 - Reverse Address Resolution Protocol (RARP)</u>

<u>Chapter 66 - Proxy ARP</u>

Chapter 67 - What's Wrong with the Address?

<u>Chapter 68 - Extending the Life of the IPv4 Address Space</u>

Chapter 69 - IP Address Assignment (The Old Method)

```
Chapter 70 - IP Addressing (The Old Method)
Chapter 71 - Address Terms and Definitions
Chapter 72 - Making the Address Efficient
Chapter 73 - Masks and Prefixes
Chapter 74 - Another Try
Chapter 75 - Variable-Length Subnet Masks
Chapter 76 - Longest Match Rule
Chapter 77 - Example One: An ISP Address Assignment
Chapter 78 - Example Two: Relaxing the Assignment
Chapter 79 - Supernetting Exposed
Chapter 80 - Route Aggregation
Chapter 81 - Determining a Common Prefix
Chapter 82 - Another Look at Route Aggregation
Chapter 83 - Classless Inter-Domain Routing (CIDR)
Chapter 84 - Classless Inter-Domain Routing (continued)
Chapter 85 - Prefix Assignments
Chapter 86 - A Look at the Addresses of an ISP
Chapter 87 - A Graphic Look at the Example
Chapter 88 - CIDR and VLSM Comparison
Chapter 89 - Special Subnet Considerations
Chapter 90 - Internet Assigned Numbers Authority
Chapter 91 - Current IANA Address Block Assignments
Chapter 92 - IP Routing
Chapter 93 - Direct Routing
Chapter 94 - Indirect Routing
Chapter 95 - A Flowchart
Chapter 96 - Routing Protocols - Distance Vector
<u>Chapter 97 - Updating Other Routers (Distance Vectors)</u>
Chapter 98 - A Bigger Update
Chapter 99 - IP Routing Tables
Chapter 100 - The Routing Information Protocol (Version 1)
Chapter 101 - RIP Operational Types
Chapter 102 - RIP Field Descriptions
Chapter 103 - Default Router and Gateways
<u>Chapter 104 - Disadvantages of the RIPv1 Protocol</u>
Chapter 105 - Scaling with RIP
Chapter 106 - Routers and Subnet Masks
Chapter 107 - RIP Fixes
Chapter 108 - Split Horizon Demonstrated
Chapter 109 - RIP Version 2
Chapter 110 - Authentication
```

```
Chapter 111 - Subnet Mask Field
Chapter 112 - Route Tag and Next-Hop Fields
Chapter 113 - Multicast Support
Chapter 114 - RIPv2 Compatibility with RIPv1
Chapter 115 - Open Shortest Path First (OSPF, RFC 2178)
Chapter 116 - An OSPF Network
Chapter 117 - A Routing Protocol Comparison
Chapter 118 - OSPF Overview
Chapter 119 - OSPF Media Support
Chapter 120 - Router Types
Chapter 121 - Router Names and Routing Methods
Chapter 122 - Message Types
Chapter 123 - Metrics (Cost)
Chapter 124 - Generic Packet Format
Chapter 125 - The Hello Protocol
Chapter 126 - Adjacency
Chapter 127 - Maintaining the Database
Chapter 128 - OSPF Areas
Chapter 129 - The Backbone Area
Chapter 130 - The Area Border Router (ABR)
Chapter 131 - Virtual Link
Chapter 132 - Inter-Area Routing
Chapter 133 - Information from Other Autonomous Systems
Chapter 134 - Stub Areas
Chapter 135 - RFCs Related to OSPF
Chapter 136 - Static versus Dynamic Routing
Chapter 137 - Remote Networks
Chapter 138 - Datagram Routing
```

Part Three - Internet Protocol Version 6 (IPv6)

<u>Chapter 139 - Introduction</u>
Chapter 140 - IPv6 Features
Chapter 141 - From IPv4 to IPv6
Chapter 142 - IP Version Numbers According to RFC 1700
Chapter 143 - IPv6 Header
Chapter 144 - IPv4 Options - A Review
Chapter 145 - IPv4 and IPv6 Header Differences
Chapter 146 - IPv6 Extension Headers
Chapter 147 - Fragmentation
Chapter 148 - Priority and Flow Label

```
Chapter 149 - IPv6 Addressing
Chapter 150 - IPv6 Addressing Prefix
Chapter 151 - 6Bone Test Addressing
Chapter 152 - Provider-Based IPv6 Addressing
Chapter 153 - Local - Use IPv6 Addressing
Chapter 154 - IPv6 Addresses with Embedded IPv4 Addresses
Chapter 155 - Unicast Addresses
Chapter 156 - Autoconfiguration
Chapter 157 - Neighbor Discovery
Chapter 158 - Neighbor Discovery Types
Chapter 159 - Neighbor Discovery and IPv4
Chapter 160 - Address Resolution
Chapter 161 - Methods of Deploying IPv6
Chapter 162 - IPv6 Tunneling Introduction
Chapter 163 - IPv6 Tunnel Addressing
Chapter 164 - IPv6 and IPv4 Dual -Stack Strategy
Chapter 165 - IPv6 Tunneling
Chapter 166 - IPv6 Tunneling
Chapter 167 - IPv6 Tunneling Flowchart 1
Chapter 168 - IPv6 Tunneling Flowchart 2
Chapter 169 - IPv6 Tunneling Flowchart 3
Chapter 170 - Anycast Addressing
Chapter 171 - Multicasting for IPv6
Chapter 172 - IPv6 Routing
Chapter 173 - RIPng
Chapter 174 - ICMP
Chapter 175 - ICMPv6 Encapsulation
Chapter 176 - ICMPv6 and ICMPv4
Chapter 177 - ICMPv6 Error Messages
Chapter 178 - ICMP Informational Messages
Chapter 179 - ICMP and Neighbor Discovery
Chapter 180 - ICMPv6 and Multicast
Chapter 181 - IPv6 Cache Entries
Chapter 182 - IPv6 Algorithm
Chapter 183 - RFCs Related to IPv6
```

Part Four - Beyond the IP Layer

Chapter 184 - Internet Control Message Protocol (ICMP)

Chapter 185 - ICMP PING

<u>Chapter 186 - More ICMP Functions</u>

```
Chapter 187 - User Datagram Protocol (UDP)
Chapter 188 - Multiplexing and Demultiplexing
Chapter 189 - Port Numbers
Chapter 190 - Assigned, Registered, and Dynamic Port Numbers
Chapter 191 - Dynamic Port Numbers
Chapter 192 - Transmission Control Protocol (TCP)
Chapter 193 - TCP Details
Chapter 194 - TCP Fields
Chapter 195 - TCP Services
Chapter 196 - TCP Connection Establishment
Chapter 197 - The Three-Way Handshake
Chapter 198 - TCP Segment
Chapter 199 - Sequence Numbers and Acknowledgments
Chapter 200 - Sequence and Acknowledgment Example
Chapter 201 - TCP Flow and Window Management
Chapter 202 - TCP Retransmission
Chapter 203 - Slow Start and Congestion Avoidance
Chapter 204 - Termination
Chapter 205 - Real-Time Protocol and the Real-Time Control Protocol
Chapter 206 - Translators
Chapter 207 - Mixers
Chapter 208 - RTP Message Format
Chapter 209 - Support for Time-Sensitive Apps
Chapter 210 - Payload Type
Chapter 211 - Providing Control for RTP
Chapter 212 - Sender Reports
Chapter 213 - Receiver Reports
Chapter 214 - Source Description Packet
Chapter 215 - Bye Message (Packet)
Chapter 216 - Application-Specific Message
Chapter 217 - Caveats
Chapter 218 - RFCs
Chapter 219 - Selected TCP/IP Applications
Chapter 220 - TELNET
Chapter 221 - TELNET Options
Chapter 222 - File Transfer Protocol (FTP)
Chapter 223 - FTP Commands
Chapter 224 - FTP Data Transfer
Chapter 225 - Trivial File Transfer Program (TFTP)
Chapter 226 - Domain Name Service (DNS)
Chapter 227 - DNS Structure
```

```
Chapter 228 - DNS Components
```

Chapter 229 - Domain Structure

Chapter 230 - Name Servers

Chapter 231 - Query Function Types

Chapter 232 - Example DNS Database

Chapter 233 - SOA Record

<u>Chapter 234 - Name Server Records</u>

Chapter 235 - Address Records

Chapter 236 - Mail Exchange Records (MX)

Chapter 237 - Playing with the Database

Chapter 238 - WHOIS Command

Chapter 239 - More DNS Information

Chapter 240 - Simple Mail Transfer Protocol (SMTP)

Chapter 241 - SMTP Functions

Chapter 242 - SMTP Flow

Chapter 243 - DNS Interaction for Mail

Chapter 244 - Post Office Protocol (POP)

Chapter 245 - POP Operation

Chapter 246 - SMTP, DNS, and POP Topology

Part Five - IP Multicast

Chapter 247 - Introduction

Chapter 248 - Multicast Components

Chapter 249 - Multicast Caveats

<u>Chapter 250 - Unicast (versus Mul ticast)</u>

Chapter 251 - Multicast (versus Unicast)

Chapter 252 - Multicasting Type

<u>Chapter 253 - Addressing Type Review</u>

Chapter 254 - Introduction to IP Multicast

<u>Chapter 255 - Extensions to the IP Service Interface</u>

<u>Chapter 256 - Receiving Multicast Datagrams</u>

<u>Chapter 257 - Address Format</u>

Chapter 258 - Mapping to an Ethernet or IEEE 802.X MAC Address

Chapter 259 - A Converted IP Multicast Address

<u>Chapter 260 - Protocols</u>

Chapter 261 - IGMP Header

Chapter 262 - Router Functions of IGMP

<u>Chapter 263 - HostJoin</u>

<u>Chapter 264 - Mul ticast Al gorithms</u>

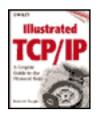
Chapter 265 - Leaves, Branches, and the Root

```
Chapter 266 - Spanning Tree and Flooding
Chapter 267 - Reverse Path Forwarding (RPF)
Chapter 268 - Pruning and Grafting (Definition)
Chapter 269 - Reverse Path Multicasting (RPM)
Chapter 270 - Core-Based Tree (CBT)
Chapter 271 - Distance Vector Multicast Routing Protocol (DVMRP)
Chapter 272 - DVMRP and IGMP
Chapter 273 - Neighbor Discovery
Chapter 274 - Route Reports
Chapter 275 - Receiving a Route Report
Chapter 276 - DVMRP Tables
Chapter 277 - DVMRP Route Tables
Chapter 278 - DVMRP Tunneling
Chapter 279 - IP-in-IP Packet Format
Chapter 280 - Protocol-Independent Multicast (PIM)
<u>Chapter 281 - PIM - Dense Mode (PIM-DM)</u>
Chapter 282 - PIM - Dense Mode Operation
Chapter 283 - Adding Interfaces
Chapter 284 - PIM - Sparse Mode (PIM-SM)
Chapter 285 - Types of Multicast Trees Using PIM-SM
Chapter 286 - Joining a Group
Chapter 287 - A Host Sending to a Group
Chapter 288 - Converting to a Source-Rooted Tree
Chapter 289 - Rendezvous Points
Chapter 290 - Comparison of Sparse- and Dense-Mode Protocols
Chapter 291 - Multicast Open Shortest Path First (MOSPF)
Chapter 292 - MOSPF Differences
Chapter 293 - MOSPF Caveats
Chapter 294 - Local-Group Database and the Group-Membership LSA
Chapter 295 - Role of the DR and the BDR
Chapter 296 - The Local-Group Database
Chapter 297 - Operation
Chapter 298 - Forwarding Cache
Chapter 299 - Inter-Area MOSPF Routing
Chapter 300 - Inter-Area Multicast Example
Chapter 301 - Inter-Area Shortest-Path Tree
Chapter 302 - Inter-Autonomous System Multicast
Chapter 303 - Multicast Conclusion
Chapter 304 - RFCs to Be Reviewed
```

```
Chapter 305 - Boot Protocol (BOOTP)
Chapter 306 - BOOTP Operation
Chapter 307 - BOOTP Field Definitions
Chapter 308 - Client Side (BOOTREQUEST)
Chapter 309 - Server Side
Chapter 310 - Chicken-or-the-Egg? Dilemma
Chapter 311 - BOOTP Relay Agents (or BOOTP Gateway)
Chapter 312 - Dynamic Host Configuration Protocol (DHCP)
Chapter 313 - DHCP
Chapter 314 - IP Address Allocation
Chapter 315 - DHCP Messages
Chapter 316 - DHCP Operation
Chapter 317 - DHCP Responses
Chapter 318 - Releasing an IP Address
Chapter 319 - DHCP Shortcuts
Chapter 320 - Lease Duration
Chapter 321 - Efficiencies
Chapter 322 - Operational Tables
Chapter 323 - RFCs to Be Reviewed
Chapter 324 - Resource Reservation Protocol (RSVP)
Chapter 325 - Alternatives
Chapter 326 - Where It Will Be Used
Chapter 327 - Operation
Chapter 328 - Path Messages
Chapter 329 - RSVP and Routers
Chapter 330 - RSVP Requests
Chapter 331 - Reservation Style
Chapter 332 - RSVP Control
Chapter 333 - Disabling a Reservation
Chapter 334 - Handling Errors
Chapter 335 - Merging Flowspecs
Chapter 336 - A Simple Example
Chapter 337 - Issues
Chapter 338 - RSVP Summary
Chapter 339 - Conclusion
Chapter 340 - Simple Network Management Protocol (SNMP)
Chapter 341 - SNMP Elements
Chapter 342 - SNMP Manager
Chapter 343 - Agent
Chapter 344 - Management Information Base (MIB)
Chapter 345 - Example MIB Entry
```

<u>Chapter 346 - The Protocol of SNMP</u> <u>Chapter 347 - SNMP Encapsulation</u>

Index



Illustrated TCP/IP

by Matthew G. Naugle Wiley Computer Publishing, John Wiley & Sons, Inc.

ISBN: 0471196568 Pub Date: 11/01/98

Previous Table of Contents Next

Acknowledgments

Two people made this book possible, Margaret Hendrey and Marjorie Spencer. I provided the information, but it was the continuous work of these two that produced this book. The amount of work it takes to put something like this together covers a long time and without these individuals' assistance, this book would not have been the same.

How to Use This Book

With the amount of information we are forced to consume everyday, it would be nice to simply skim over a few sentences in a paragraph to get the key points of the topic. That is what the Illustrated Network books are about. Each page has a graphic and concise text that makes key points quick to learn and review.

Like all books in the Illustrated Network series, this one is very detailed, yet it is written in way that makes it easy to comprehend. Eighty percent of what is commonly written about is filler information. What this book does is extract the twenty percent of the required information and places this information in an easy to use format. A similar format is used quite often with training material. As we all know, training must be done is a very structured and concise fashion and it must be delivered within a limited window of time. I have taken this quick learning concept further by using a combination of a text book and a training manual—producing the format of this book.

This book is built specifically to be used as both a reference manual and a text book. There is no reason to read it from cover to cover. A topic can simply be turned to and quickly learned without having to read the whole book.

The back of the book contains a CD. The graphics containing all the key points of the lessons are provided on this CD. You can use the graphics to create a customized training slide show, or use them in a classroom setting in conjunction with the book. The files are in a Microsoft PowerPoint presentation. The version of PowerPoint used is PowerPoint 97. Simply start your PowerPoint application and open one of the files on the CD corresponding to the information in the book.

This book is dedicated to a good friend of mine, for whom I continue to have great admiration. His tireless instruction of limitless boundaries will forever be remembered. His thoughts and ideas were given to me years ago, but I continue to use them successfully everyday.

This book is dedicated to John J. (JJ) Anderson.

Previous Table of Contents Next