

CCNAv7: Intoduction to Network (ITN)

Companion Guide



Ilili Networking cisco Academy

Contents at a Glance

	Introduction xxx
Chapter 1	Networking Today 1
Chapter 2	Basic Switch and End Device Configuration 45
Chapter 3	Protocols and Models 85
Chapter 4	Physical Layer 137
Chapter 5	Number Systems 175
Chapter 6	Data Link Layer 203
Chapter 7	Ethernet Switching 233
Chapter 8	Network Layer 267
Chapter 9	Address Resolution 297
Chapter 10	Basic Router Configuration 319
Chapter 11	IPv4 Addressing 341
Chapter 12	IPv6 Addressing 397
Chapter 13	ICMP 443
Chapter 14	Transport Layer 461
Chapter 15	Application Layer 507
Chapter 16	Network Security Fundamentals 541
Chapter 17	Build a Small Network 571
Appendix A	Answers to "Check Your Understanding" Questions 631
	Key Terms Glossary 645
	Index 660

Contents

```
Introduction xxx
Chapter 1
               Networking Today 1
               Objectives 1
               Key Terms 1
               Introduction (1.0) 3
               Networks Affect Our Lives (1.1) 3
                  Networks Connect Us (1.1.1) 3
                  No Boundaries (1.1.3) 3
               Network Components (1.2) 4
                  Host Roles (1.2.1) 4
                  Peer-to-Peer (1.2.2) 5
                  End Devices (1.2.3) 6
                  Intermediary Devices (1.2.4) 6
                  Network Media (1.2.5) 7
               Network Representations and Topologies (1.3) 8
                  Network Representations (1.3.1) 8
                  Topology Diagrams (1.3.2) 10
                     Physical Topology Diagrams 10
                     Logical Topology Diagrams 10
               Common Types of Networks (1.4) 11
                  Networks of Many Sizes (1.4.1) 11
                  LANs and WANs (1.4.2) 12
                     LANs 13
                     WANs 14
                  The Internet (1.4.3) 15
                  Intranets and Extranets (1.4.4) 16
               Internet Connections (1.5) 17
                  Internet Access Technologies (1.5.1) 17
                  Home and Small Office Internet Connections (1.5.2) 18
                  Businesses Internet Connections (1.5.3) 19
                  The Converging Network (1.5.4) 20
```

Reliable Networks (1.6) 23 Network Architecture (1.6.1) 23 Fault Tolerance (1.6.2) 24 Scalability (1.6.3) 24 Quality of Service (1.6.4) 25 Network Security (1.6.5) 26 Network Trends (1.7) 27 Recent Trends (1.7.1) 28 Bring Your Own Device (BYOD) (1.7.2) 28 Online Collaboration (1.7.3) 28 Video Communications (1.7.4) 29 Cloud Computing (1.7.6) 29 Technology Trends in the Home (1.7.7) 31 Powerline Networking (1.7.8) 31 Wireless Broadband (1.7.9) 32 Wireless Internet Service Providers 32 Wireless Broadband Service 32 Network Security (1.8) 33 Security Threats (1.8.1) 33 Security Solutions (1.8.2) 34 The IT Professional (1.9) 35 CCNA (1.9.1) 35 Networking Jobs (1.9.2) 36 Summary (1.10) 37 Networks Affect Our Lives 37 Network Components 37 Network Representations and Topologies 37 Common Types of Networks 37 Internet Connections 38 Reliable Networks 38 Network Trends 38 Network Security 39 The IT Professional 40 Practice **Check Your Understanding Questions 40**

Chapter 2 **Basic Switch and End Device Configuration** 45 **Objectives 45** Key Terms 45 Introduction (2.0) 46 Cisco IOS Access (2.1) 46 Operating Systems (2.1.1) GUI (2.1.2) 47 Purpose of an OS (2.1.3) 48 Access Methods (2.1.4) 49 Terminal Emulation Programs (2.1.5) 50 IOS Navigation (2.2) 52 Primary Command Modes (2.2.1) 52 Configuration Mode and Subconfiguration Modes (2.2.2) 53 Navigate Between IOS Modes (2.2.4) 54 A Note About Syntax Checker Activities (2.2.6) 55 The Command Structure (2.3) 56 Basic IOS Command Structure (2.3.1) 56 IOS Command Syntax Check (2.3.2) 57 IOS Help Features (2.3.3) 58 Hot Keys and Shortcuts (2.3.5) 58 **Basic Device Configuration (2.4) 61** Device Names (2.4.1) 61 Password Guidelines (2.4.2) 62 Configure Passwords (2.4.3) 63 Encrypt Passwords (2.4.4) 64 Banner Messages (2.4.5) 65 Save Configurations (2.5) 66 Configuration Files (2.5.1) 67 Alter the Running Configuration (2.5.2) 68 Capture Configuration to a Text File (2.5.4) 68 Ports and Addresses (2.6) 71 IP Addresses (2.6.1) 71 Interfaces and Ports (2.6.2) 73

Configure IP Addressing (2.7) 74

Manual IP Address Configuration for End Devices (2.7.1) 75 Automatic IP Address Configuration for End Devices (2.7.2) 76 Switch Virtual Interface Configuration (2.7.4) 77

Verify Connectivity (2.8) 78

Summary (2.9) 79

Cisco IOS Access 79

IOS Navigation 79

The Command Structure 79

Basic Device Configuration 79

Save Configurations 80

Ports and Addresses 80

Configure IP Addressing 80

Verify Connectivity 80

Practice 81

Check Your Understanding Questions 81

Chapter 3 Protocols and Models 85

Objectives 85

Key Terms 85

Introduction (3.0) 86

The Rules (3.1) 86

Communications Fundamentals (3.1.2) 86

Communication Protocols (3.1.3) 87

Rule Establishment (3.1.4) 88

Network Protocol Requirements (3.1.5) 88

Message Encoding (3.1.6) 89

Message Formatting and Encapsulation (3.1.7) 90

Message Size (3.1.8) 91

Message Timing (3.1.9) 92

Message Delivery Options (3.1.10) 92

A Note About the Node Icon (3.1.11) 94

Protocols 94

Network Protocol Overview (3.2.1) 94

Network Protocol Functions (3.2.2) 95

Protocol Interaction (3.2.3) 96

Network Protocol Suites (3.3.1) 97 Evolution of Protocol Suites (3.3.2) 98 TCP/IP Protocol Example (3.3.3) 99 TCP/IP Protocol Suite (3.3.4) 99 Application Layer 101 Transport Layer 102 Internet Layer 102 Network Access Layer 103 TCP/IP Communication Process (3.3.5) 103 Standards Organizations (3.4) 108 Open Standards (3.4.1) 108 Internet Standards (3.4.2) 108 Electronic and Communications Standards (3.4.3) 111 Reference Models (3.5) 111 The Benefits of Using a Layered Model (3.5.1) 112 The OSI Reference Model (3.5.2) 112 The TCP/IP Protocol Model (3.5.3) 114 OSI and TCP/IP Model Comparison (3.5.4) 115 Data Encapsulation (3.6) 116 Segmenting Messages (3.6.1) 116 Sequencing (3.6.2) 118 Protocol Data Units (3.6.3) 118 Encapsulation Example (3.6.4) 120 De-encapsulation Example (3.6.5) 120 Data Access (3.7) 121 Addresses (3.7.1) 121 Layer 3 Logical Address (3.7.2) 122 Devices on the Same Network (3.7.3) 123 Role of the Data Link Layer Addresses: Same IP Network (3.7.4) 124 Devices on a Remote Network (3.7.5) 125 Role of the Network Layer Addresses (3.7.6) 125 Role of the Data Link Layer Addresses: Different IP Networks (3.7.7) 126 Data Link Addresses (3.7.8) 127

Protocol Suites (3.3) 97

Summary (3.8) 130 The Rules 130 Protocols 130 Protocol Suites 130 Standards Organizations 131 Reference Models 131 Data Encapsulation 132 Data Access 132 Practice 133 **Check Your Understanding Questions 133 Chapter 4** Physical Layer 137 **Objectives 137** Key Terms 137 Introduction (4.0) 138 Purpose of the Physical Layer (4.1) 138 The Physical Connection (4.1.1) 138 The Physical Layer (4.1.2) 139 Physical Layer Characteristics (4.2) 141 Physical Layer Standards (4.2.1) 141 Physical Components (4.2.2) 142 Encoding (4.2.3) 142 Signaling (4.2.4) 143 Bandwidth (4.2.5) 145 Bandwidth Terminology (4.2.6) 145 Latency 146 Throughput 146 Goodput 146 Copper Cabling (4.3) 146 Characteristics of Copper Cabling (4.3.1) 147 Types of Copper Cabling (4.3.2) 148 Unshielded Twisted-Pair (UTP) (4.3.3) 148 Shielded Twisted-Pair (STP) (4.3.4) 150 Coaxial Cable (4.3.5) 151

UTP Cabling (4.4) 152 Properties of UTP Cabling (4.4.1) 152 UTP Cabling Standards and Connectors (4.4.2) 153 Straight-Through and Crossover UTP Cables (4.4.3) 157 Fiber-Optic Cabling (4.5) 158 Properties of Fiber-Optic Cabling (4.5.1) Types of Fiber Media (4.5.2) 159 Single-Mode Fiber 159 Multimode Fiber 160 Fiber-Optic Cabling Usage (4.5.3) 160 Fiber-Optic Connectors (4.5.4) 161 Fiber Patch Cords (4.5.5) 162 Fiber Versus Copper (4.5.6) 163 Wireless Media (4.6) 164 Properties of Wireless Media (4.6.1) 164 Types of Wireless Media (4.6.2) 165 Wireless LAN (4.6.3) 166 **Summary (4.7) 168** Purpose of the Physical Layer 168 Physical Layer Characteristics Copper Cabling 168 UTP Cabling 169 Fiber-Optic Cabling 169 Wireless Media 169 Practice 170 **Check Your Understanding Questions** 170 **Number Systems** 175 **Objectives 175** Key Terms 175 Introduction (5.0) 176 Binary Number System (5.1) 176 Binary and IPv4 Addresses (5.1.1) Binary Positional Notation (5.1.3)

Chapter 5

```
Convert Binary to Decimal (5.1.5) 180
                  Decimal to Binary Conversion (5.1.7) 182
                  Decimal to Binary Conversion Example (5.1.8) 186
                 IPv4 Addresses (5.1.11) 193
               Hexadecimal Number System (5.2) 194
                  Hexadecimal and IPv6 Addresses (5.2.1) 194
                  Decimal to Hexadecimal Conversions (5.2.3) 196
                 Hexadecimal to Decimal Conversion (5.2.4) 196
               Summary (5.3) 198
                 Binary Number System 198
                 Hexadecimal Number System
               Practice 198
               Check Your Understanding Questions 198
Chapter 6
               Data Link Layer 203
               Objectives 203
               Key Terms 203
              Introduction (6.0) 204
               Purpose of the Data Link Layer (6.1) 204
                 The Data Link Layer (6.1.1) 204
                 IEEE 802 LAN/MAN Data Link Sublayers (6.1.2) 206
                 Providing Access to Media (6.1.3) 207
                 Data Link Layer Standards (6.1.4) 209
               Topologies (6.2) 209
                  Physical and Logical Topologies (6.2.1) 209
                  WAN Topologies (6.2.2) 211
                    Point-to-Point 211
                    Hub and Spoke 211
                    Mesh 212
                  Point-to-Point WAN Topology (6.2.3) 213
                 LAN Topologies (6.2.4) 213
                    Legacy LAN Topologies 214
                 Half-Duplex and Full-Duplex Communication (6.2.5) 215
                    Half-Duplex Communication 215
                    Full-Duplex Communication 215
```

Access Control Methods (6.2.6) 216 Contention-Based Access 216 Controlled Access 217 Contention-Based Access—CSMA/CD (6.2.7) 217 Contention-Based Access—CSMA/CA (6.2.8) 219 Data Link Frame (6.3) 221 The Frame (6.3.1) 221 Frame Fields (6.3.2) 222 Layer 2 Addresses (6.3.3) 223 LAN and WAN Frames (6.3.4) 225 Summary (6.4) 228 Purpose of the Data Link Layer 228 Topologies 228 Data Link Frame 229 Practice 229 **Check Your Understanding Questions 229 Ethernet Switching 233 Objectives 233** Key Terms 233 Introduction (7.0) 234 Ethernet Frames (7.1) 234 Ethernet Encapsulation (7.1.1) 234 Data Link Sublayers (7.1.2) 235 MAC Sublayer (7.1.3) 236 Data Encapsulation 236 Accessing the Media 237 Ethernet Frame Fields (7.1.4) 237 Ethernet MAC Address (7.2) 239 MAC Address and Hexadecimal (7.2.1) 240 Ethernet MAC Address (7.2.2) 241 Frame Processing (7.2.3) 243 Unicast MAC Address (7.2.4) 244 Broadcast MAC Address (7.2.5) 246 Multicast MAC Address (7.2.6) 247

Chapter 7

The MAC Address Table (7.3) 248 Switch Fundamentals (7.3.1) 248 Switch Learning and Forwarding (7.3.2) 250 Examine the Source MAC Address 250 Find the Destination MAC Address 250 Filtering Frames (7.3.3) 252 Switch Speeds and Forwarding Methods (7.4) 254 Frame Forwarding Methods on Cisco Switches (7.4.1) 254 Cut-Through Switching (7.4.2) 255 Memory Buffering on Switches (7.4.3) 257

Summary (7.5) 261

Auto-MDIX (7.4.5) 259

Ethernet Frame 261 Ethernet MAC Address 261 The MAC Address Table 261 Switch Speeds and Forwarding Methods 262

Duplex and Speed Settings (7.4.4) 257

Practice 262

Check Your Understanding Questions 262

Chapter 8 Network Layer 267

Objectives 267

Key Terms 267

Introduction (8.0) 268

Network Layer Characteristics (8.1) 268

The Network Layer (8.1.1) 268

IP Encapsulation (8.1.2) 270

Characteristics of IP (8.1.3) 271

Connectionless (8.1.4) 271

Best Effort (8.1.5) 272

Media Independent (8.1.6) 273

IPv4 Packet (8.2) 274

IPv4 Packet Header (8.2.1) 274

IPv4 Packet Header Fields (8.2.2) 274

IPv6 Packet (8.3) 276

Limitations of IPv4 (8.3.1) 277

IPv6 Overview (8.3.2) 277

```
IPv6 Packet Header (8.3.4) 280
               How a Host Routes (8.4) 281
                  Host Forwarding Decision (8.4.1) 281
                  Default Gateway (8.4.2) 282
                  A Host Routes to the Default Gateway (8.4.3) 283
                  Host Routing Tables (8.4.4) 283
               Introduction to Routing (8.5) 285
                  Router Packet Forwarding Decision (8.5.1) 285
                  IP Router Routing Table (8.5.2) 286
                  Static Routing (8.5.3) 287
                  Dynamic Routing (8.5.4) 288
                  Introduction to an IPv4 Routing Table (8.5.6) 290
               Summary (8.6) 292
                  Network Layer Characteristics 292
                  IPv4 Packet 292
                  IPv6 Packet 292
                  How a Host Routes 293
                  Introduction to Routing 293
               Practice 294
               Check Your Understanding Questions 294
Chapter 9
               Address Resolution 297
               Objectives 297
               Key Terms 297
               Introduction (9.0) 298
               MAC and IP (9.1) 298
                  Destination on Same Network (9.1.1) 298
                  Destination on Remote Network (9.1.2) 299
               ARP (9.2) 301
                  ARP Overview (9.2.1) 301
                  ARP Functions (9.2.2) 302
                  Removing Entries from an ARP Table (9.2.6) 306
                  ARP Tables on Networking Devices (9.2.7) 306
                  ARP Issues—ARP Broadcasts and ARP Spoofing (9.2.8) 307
```

IPv4 Packet Header Fields in the IPv6 Packet Header (8.3.3) 278

IPv6 Neighbor Discovery Messages (9.3.2) 309 IPv6 Neighbor Discovery—Address Resolution (9.3.3) 311 Summary (9.4) 313 MAC and IP 313 ARP 313 Neighbor Discovery 314 Practice 314 **Check Your Understanding Questions 314** Chapter 10 **Basic Router Configuration 319 Objectives 319** Introduction (10.0) 320 Configure Initial Router Settings (10.1) 320 Basic Router Configuration Steps (10.1.1) 320 Basic Router Configuration Example (10.1.2) 321 Configure Interfaces (10.2) 323 Configure Router Interfaces (10.2.1) 323 Configure Router Interfaces Example (10.2.2) Verify Interface Configuration (10.2.3) 325 Configuration Verification Commands (10.2.4) 326 Configure the Default Gateway (10.3) 330 Default Gateway on a Host (10.3.1) 331 Default Gateway on a Switch (10.3.2) 332 Summary (10.4) 335 Configure Initial Router Settings 335 Configure Interfaces 335 Configure the Default Gateway 335 Practice 336 **Check Your Understanding Questions 337** Chapter 11 IPv4 Addressing 341 **Objectives 341** Key Terms 341 Introduction (11.0) 342

IPv6 Neighbor Discovery (9.3) 309

IPv4 Address Structure (11.1) 342 Network and Host Portions (11.1.1) 342 The Subnet Mask (11.1.2) 343 The Prefix Length (11.1.3) 344 Determining the Network: Logical AND (11.1.4) 345 Network, Host, and Broadcast Addresses (11.1.6) 347 Network Address 347 Host Addresses 348 Broadcast Address 349 IPv4 Unicast, Broadcast, and Multicast (11.2) 349 Unicast (11.2.1) 349 Broadcast (11.2.2) 350 IP Directed Broadcasts 351 Multicast (11.2.3) 352 Types of IPv4 Addresses (11.3) 353 Public and Private IPv4 Addresses (11.3.1) 353 Routing to the Internet (11.3.2) 354 Special Use IPv4 Addresses (11.3.4) 356 Loopback Addresses 356 Link-Local Addresses 357 Legacy Classful Addressing (11.3.5) 357 Assignment of IP Addresses (11.3.6) 358 Network Segmentation (11.4) 359 Broadcast Domains and Segmentation (11.4.1) 359 Problems with Large Broadcast Domains (11.4.2) 360 Reasons for Segmenting Networks (11.4.3) 362 Subnet an IPv4 Network (11.5) 364 Subnet on an Octet Boundary (11.5.1) 364 Subnet Within an Octet Boundary (11.5.2) 366 Subnet a Slash 16 and a Slash 8 Prefix (11.6) 367 Create Subnets with a Slash 16 Prefix (11.6.1) 367 Create 100 Subnets with a Slash 16 Prefix (11.6.2) 369 Create 1000 Subnets with a Slash 8 Prefix (11.6.3) 372 Subnet to Meet Requirements (11.7) 374 Subnet Private Versus Public IPv4 Address Space (11.7.1) 374

What About the DMZ? 377

Chapter 12

```
Minimize Unused Host IPv4 Addresses and Maximize
     Subnets (11.7.2) 377
   Example: Efficient IPv4 Subnetting (11.7.3) 378
VLSM (11.8) 381
   IPv4 Address Conservation (11.8.3) 381
   VLSM (11.8.4) 383
   VLSM Topology Address Assignment (11.8.5) 386
Structured Design (11.9) 387
   IPv4 Network Address Planning (11.9.1) 388
   Device Address Assignment (11.9.2) 389
Summary (11.10) 390
   IPv4 Addressing Structure 390
   IPv4 Unicast, Broadcast, and Multicast 390
   Types of IPv4 Addresses 390
   Network Segmentation 391
   Subnet an IPv4 Network 391
   Subnet a /16 and a /8 Prefix 391
   Subnet to Meet Requirements 391
   Variable-Length Subnet Masking 392
   Structured Design 392
Practice 393
Check Your Understanding Questions 393
IPv6 Addressing 397
Objectives 397
Key Terms 397
Introduction (12.0) 398
IPv4 Issues (12.1) 398
   Need for IPv6 (12.1.1) 398
     Internet of Things 399
   IPv4 and IPv6 Coexistence (12.1.2) 399
     Dual Stack 399
     Tunneling 400
     Translation 401
```

IPv6 Address Representation (12.2) 401 IPv6 Addressing Formats (12.2.1) 401 Preferred Format 402 Rule 1—Omit Leading Zeros (12.2.2) 403 Rule 2—Double Colon (12.2.3) 404 IPv6 Address Types (12.3) 406 Unicast, Multicast, Anycast (12.3.1) 406 IPv6 Prefix Length (12.3.2) 406 Types of IPv6 Unicast Addresses (12.3.3) A Note About the Unique Local Address (12.3.4) 408 IPv6 GUA (12.3.5) 408 IPv6 GUA Structure (12.3.6) 409 Global Routing Prefix 410 Subnet ID 410 Interface ID 410 IPv6 LLA (12.3.7) 411 **GUA and LLA Static Configuration (12.4) 413** Static GUA Configuration on a Router (12.4.1) 413 Static GUA Configuration on a Windows Host (12.4.2) 414 Static Configuration of a Link-Local Unicast Address (12.4.3) 415 Dynamic Addressing for IPv6 GUAs (12.5) 417 RS and RA Messages (12.5.1) 417 Method 1: SLAAC (12.5.2) 418 Method 2: SLAAC and Stateless DHCPv6 (12.5.3) 419 Method 3: Stateful DHCPv6 (12.5.4) 420 EUI-64 Process vs. Randomly Generated (12.5.5) 421 EUI-64 Process (12.5.6) 422 Randomly Generated Interface IDs (12.5.7) 424 Dynamic Addressing for IPv6 LLAs (12.6) 425 Dynamic LLAs (12.6.1) 425 Dynamic LLAs on Windows (12.6.2) 425 Dynamic LLAs on Cisco Routers (12.6.3) 426 Verify IPv6 Address Configuration (12.6.4) 427

IPv6 Multicast Addresses (12.7) 430

Assigned IPv6 Multicast Addresses (12.7.1) 430 Well-Known IPv6 Multicast Addresses (12.7.2) 430 Solicited-Node IPv6 Multicast Addresses (12.7.3) 432

Subnet an IPv6 Network (12.8) 432

Subnet Using the Subnet ID (12.8.1) 432 IPv6 Subnetting Example (12.8.2) 433 IPv6 Subnet Allocation (12.8.3) 434 Router Configured with IPv6 Subnets (12.8.4) 435

Summary (12.9) 436

IPv4 Issues 436 IPv6 Address Representation 436 IPv6 Address Types 436 GUA and LLA Static Configuration 437 Dynamic Addressing for IPv6 GUAs 437 Dynamic Addressing for IPv6 LLAs 437 IPv6 Multicast Addresses 438 Subnet an IPv6 Network 438

Practice 439

Check Your Understanding Questions 439

Chapter 13 ICMP 443

Objectives 443

Introduction (13.0) 444

ICMP Messages (13.1) 444

ICMPv4 and ICMPv6 Messages (13.1.1) 444 Host Reachability (13.1.2) 444 Destination or Service Unreachable (13.1.3) 445 Time Exceeded (13.1.4) 446 ICMPv6 Messages (13.1.5) 446

Ping and Traceroute Tests (13.2) 449

Ping—Test Connectivity (13.2.1) 449 Ping the Loopback (13.2.2) 450 Ping the Default Gateway (13.2.3) 450 Ping a Remote Host (13.2.4) 451

```
Round-Trip Time (RTT) 453
                     IPv4 TTL and IPv6 Hop Limit 453
               Summary (13.3) 454
                  ICMP Messages 454
                  Ping and Traceroute Testing 454
               Practice 455
               Check Your Understanding Questions 456
Chapter 14
               Transport Layer 461
               Objectives 461
               Key Terms 461
              Introduction (14.0) 462
               Transportation of Data (14.1) 462
                  Role of the Transport Layer (14.1.1) 462
                  Transport Layer Responsibilities (14.1.2) 463
                  Transport Layer Protocols (14.1.3) 467
                  Transmission Control Protocol (TCP) (14.1.4) 467
                  User Datagram Protocol (UDP) (14.1.5) 468
                  The Right Transport Layer Protocol for the Right
                    Application (14.1.6) 469
               TCP Overview (14.2) 470
                  TCP Features (14.2.1) 470
                  TCP Header (14.2.2) 471
                  TCP Header Fields (14.2.3) 471
                  Applications That Use TCP (14.2.4) 472
               UDP Overview (14.3) 473
                  UDP Features (14.3.1) 473
                  UDP Header (14.3.2) 474
                  UDP Header Fields (14.3.3) 474
                  Applications that use UDP (14.3.4) 475
               Port Numbers (14.4) 476
                  Multiple Separate Communications (14.4.1) 476
                  Socket Pairs (14.4.2) 477
                  Port Number Groups (14.4.3) 478
                  The netstat Command (14.4.4) 479
```

Traceroute—Test the Path (13.2.5) 452

Chapter 15

TCP Communication Process (14.5) 480 TCP Server Processes (14.5.1) 480 TCP Connection Establishment (14.5.2) 483 Session Termination (14.5.3) 484 TCP Three-Way Handshake Analysis (14.5.4) 485 Reliability and Flow Control (14.6) 486 TCP Reliability—Guaranteed and Ordered Delivery (14.6.1) 486 TCP Reliability—Data Loss and Retransmission (14.6.3) 488 TCP Flow Control—Window Size and Acknowledgments (14.6.5) 490 TCP Flow Control—Maximum Segment Size (MSS) (14.6.6) TCP Flow Control—Congestion Avoidance (14.6.7) 493 UDP Communication (14.7) 494 UDP Low Overhead Versus Reliability (14.7.1) 494 UDP Datagram Reassembly (14.7.2) 494 UDP Server Processes and Requests (14.7.3) 495 UDP Client Processes (14.7.4) 495 Summary (14.8) 499 Transportation of Data 499 TCP Overview 499 UDP Overview 499 Port Numbers 499 TCP Communications Process 500 Reliability and Flow Control 500 UDP Communication 501 Practice 501 **Check Your Understanding Questions 502 Application Layer** 507 **Objectives 507** Key Terms 507 Introduction (15.0) 508 Application, Presentation, and Session (15.1) 508 Application Layer (15.1.1) 508 Presentation and Session Layer (15.1.2) 508 TCP/IP Application Layer Protocols (15.1.3) 510

Client-Server Model (15.2.1) 511 Peer-to-Peer Networks (15.2.2) 512 Peer-to-Peer Applications (15.2.3) 513 Common P2P Applications (15.2.4) 514 Web and Email Protocols (15.3) 515 Hypertext Transfer Protocol and Hypertext Markup Language (15.3.1) 515 HTTP and HTTPS (15.3.2) 516 Email Protocols (15.3.3) 518 SMTP, POP, and IMAP (15.3.4) 519 SMTP 519 POP 520 IMAP 521 IP Addressing Services (15.4) 521 Domain Name Service (15.4.1) 522 DNS Message Format (15.4.2) 524 DNS Hierarchy (15.4.3) 525 The nslookup Command (15.4.4) 526 Dynamic Host Configuration Protocol (15.4.6) 527 DHCP Operation (15.4.7) 528 File Sharing Services (15.5) 530 File Transfer Protocol (15.5.1) 530 Server Message Block (15.5.2) 531 Summary 534 Application, Presentation, and Session 534 Peer-to-Peer 534 Web and Email Protocols 534 IP Addressing Services 535 File Sharing Services 535 Practice 536 **Check Your Understanding Questions 536**

Peer-to-Peer (15.2) 511

```
Chapter 16
               Network Security Fundamentals 541
               Objectives 541
               Key Terms 541
               Introduction (16.0) 542
               Security Threats and Vulnerabilities (16.1) 542
                  Types of Threats (16.1.1) 542
                  Types of Vulnerabilities (16.1.2) 543
                  Physical Security (16.1.3) 545
               Network Attacks (16.2) 546
                  Types of Malware (16.2.1) 546
                     Viruses 546
                     Worms 547
                     Trojan Horses 547
                  Reconnaissance Attacks (16.2.2) 547
                  Access Attacks (16.2.3) 548
                     Password Attacks 548
                     Trust Exploitation 548
                     Port Redirection 549
                     Man-in-the-Middle 549
                  Denial of Service Attacks (16.2.4) 551
                     DoS Attack 551
                     DDoS Attack 551
               Network Attack Mitigations (16.3) 552
                  The Defense-in-Depth Approach (16.3.1) 553
                  Keep Backups (16.3.2) 553
                  Upgrade, Update, and Patch (16.3.3) 554
                  Authentication, Authorization, and Accounting (16.3.4) 555
                  Firewalls (16.3.5) 555
                  Types of Firewalls (16.3.6) 557
                  Endpoint Security (16.3.7)
                                           558
               Device Security (16.4) 558
                  Cisco AutoSecure (16.4.1)
                                           558
                  Passwords (16.4.2) 559
                  Additional Password Security (16.4.3) 560
                  Enable SSH (16.4.4) 561
                  Disable Unused Services (16.4.5) 563
```

Security Threats and Vulnerabilities 565 Network Attacks 565 Network Attack Mitigation 565 Device Security 566 Practice 567 **Check Your Understanding Questions 567 Build a Small Network 571 Objectives 571** Key Terms 571 Introduction (17.0) 572 Devices in a Small Network (17.1) 572 Small Network Topologies (17.1.1) 572 Device Selection for a Small Network (17.1.2) 573 Cost 573 Speed and Types of Ports/Interfaces 573 Expandability 573 Operating System Features and Services 574 IP Addressing for a Small Network (17.1.3) 574 Redundancy in a Small Network (17.1.4) 576 Traffic Management (17.1.5) 577 Small Network Applications and Protocols (17.2) 578 Common Applications (17.2.1) 578 Network Applications 578 Application Layer Services 579 Common Protocols (17.2.2) 579 Voice and Video Applications (17.2.3) 582 Scale to Larger Networks (17.3) 583 Small Network Growth (17.3.1) 583 Protocol Analysis (17.3.2) 583 Employee Network Utilization (17.3.3) 584 Verify Connectivity (17.4) 586 Verify Connectivity with Ping (17.4.1) 586 Extended Ping (17.4.2) 588 Verify Connectivity with Traceroute (17.4.3) 590

Summary 565

Chapter 17

xxviii Introduction to Networks C	ompanion Guide (CCNAv7)
	Extended Traceroute (17.4.4) 592
	Network Baseline (17.4.5) 593
	Host and IOS Commands (17.5) 596
	IP Configuration on a Windows Host (17.5.1) 596
	IP Configuration on a Linux Host (17.5.2) 599
	IP Configuration on a macOS Host (17.5.3) 600
	The arp Command (17.5.4) 601
	Common show Commands Revisited (17.5.5) 602
	The show cdp neighbors Command (17.5.6) 609
	The show ip interface brief Command (17.5.7) 610
	Verify Switch Interfaces 611
	Troubleshooting Methodologies (17.6) 611
	Basic Troubleshooting Approaches (17.6.1) 612
	Resolve or Escalate? (17.6.2) 613
	The debug Command (17.6.3) 613
	The terminal monitor Command (17.6.4) 615
	Troubleshooting Scenarios (17.7) 616
	Duplex Operation and Mismatch Issues (17.7.1) 617
	IP Addressing Issues on IOS Devices (17.7.2) 618
	IP Addressing Issues on End Devices (17.7.3) 619
	Default Gateway Issues (17.7.4) 619
	Troubleshooting DNS Issues (17.7.5) 621
	Summary (17.8) 624
	Devices in a Small Network 624
	Small Network Applications and Protocols 624
	Scale to Larger Networks 624
	Verify Connectivity 625
	Host and IOS Commands 625
	Troubleshooting Methodologies 626
	Troubleshooting Scenarios 626
	Practice 627
	Check Your Understanding Questions 628
Appendix A	Answers to "Check Your Understanding" Questions 631
	Key Terms Glossary 645
	Index 669