

Symbols

? (question mark), locating commands in CLI, 67-68

A

access-list command

- ACL configuration, 375-377
- extended ACL port number option, 395-398
- extended ACL protocol option, 393-394

accessing, router console ports, 26-27, 62

ACK flags, 344

Acknowledgment Number field (TCP), 347

acknowledgments (TCP), flow control, 343

ACLs, 366

- configuring, 375-377
- design recommendations, 379-380
- detail, displaying, 385
- disabling, 377
- extended IP, 371-372
- functions of, 367-368
- implicit deny logic, 374
- inbound/outbound filtering, 369-371
- matching-criteria, 373
- modifying current configuration, 378-379
- multiple statement processing, 373-374
- named IP
 - configuring, 398-400
 - editing, 401
- number ranges, 376
- numbered extended, configuring, 390-398
- numbered standard, configuring, 386-390
- packet filtering rules, 368
- permit/deny statements, 373
- placing, 402-403
- verifying, 385-386
- wildcard masks, 380-381
 - keywords, 383
 - potential complexity of, 382
 - selecting, 384

adjusting RIP timers, 248-249

administrative distance, 197, 301-302

- best path selection, 258-259
- on static routes, 198-199

advertising default routes, 299

- RIP, 260
- with ip default-network command, 300-301

advertisements, CDP holdtime, 121

algorithms, 206

any keyword, 383

application processes, port numbers, 353-355

- well-known ports, 354

applications, text editors, 177

applying

- ACLs to interfaces, 376-377
- structured troubleshooting method to network problems, 308-309

AS (autonomous systems), 205

ASN (autonomous system number), 205

assigning hostname to routers, 92

asynchronous communication, 27

asynchronous serial interfaces, 22

aux ports, 24

- cabling, 28
- comparing with console port, 28-29

B

backup configuration files, 106

- backing up with TFTP, 107-109
- storing, 109-110

banner command, 104

Bell, Alexander Graham, 7

best path selection, 256

- administrative distance, 301-302
- based on administrative distance, 258-259
- CEF, 258
- load balancing, 256
- using metrics, 302-303

best practices for ACL configuration, 379-380

BGP (Border Gateway Protocol), 205, 256

boot field, 57

boot process, 52

- bootstrap program, loading, 54
- Cisco IOS, loading, 56-57
 - configuration register, 57*
 - startup configuration, loading, 58*
- LED indicators, 53
- POST, 54

boot ROM software, 51**bootstrap program, loading, 54****bps (bits per second), 62****buses, 16****C**

cabling, 19-20

- for leased lines, 21-22
- router aux ports, 28

CDP (Cisco Discovery Protocol)

- enabling on a router, 126-128
- learned information, viewing, 123-125
- message encapsulation, 120
- neighbor discovery, 118
- network maps, creating, 128-130
- timers, 121-123
- verifying configuration, 125-128
- versions of, comparing, 121

cdp command

- Layer 1 problems, troubleshooting, 324-325
- Layer 2 problems, troubleshooting, 324-325

cdp holdtime command, 131**cdp timers command, 131****CEF (Cisco Express Forwarding), best path selection, 258****circuit-switched WANs, 22-23****Cisco IOS software, 14, 47**

- CLI. *See* CLI
- configuration modes, switching between, 64
- configuration register, 57
- feature sets, 165
- filenames, 164, 166
- images, 47
 - feature sets, 47*
 - loading decision logic, 153-158*
 - loading process, troubleshooting, 160-161*
 - locating on TFTP server, 159*
 - managing, 166*
 - verifying, 174*
- initial configuration
 - creating, 59-60*
 - setup process, 61*
- loading, 56-57
- minimum RAM requirements, determining, 50

- selecting, 156
- startup configuration, loading, 58-59
- subconfiguration modes, 86

Cisco Software Advisor, 50**classful addressing, 263****classful networks, 247****classful routing protocols, 243, 261-263****classless addressing, 263****classless routing protocols, 243, 261-263****clear cdp table command, 131****CLI (command-line interface), 40**

- commands
 - editing, 71-72*
 - error messages, displaying, 73-74*
 - locating, 67-68*
 - options, 68-70*
 - recalling, 70*
- configuration modes, 64

clock rate, configuring on serial links, 88**clock rate command, 11****clocking, 27****COM ports, 25****commands**

- banner, 104
- cdp holdtime, 131
- cdp timers, 131
- clear cdp table, 131
- clock rate, 11, 88
- config-register, 173
- configuration file-related, updated command styles, 162-163
- configure terminal, 46, 85
- copy, 167
- copy startup-config running-config, 100
- copy tftp flash, 167
- debug, 331-332
- debug cdp events, 131
- debug cdp ip, 131
- editing in CLI, 71-72
- erase startup-config, 182
- error messages about, displaying, 73-74
- ip route, 195
- locating in CLI, 67-68
- login, 94
- network, 219, 244
- no ip domain-lookup, 136
- no shutdown, 181
- options, locating in CLI, 68-70
- parameters, syntax, 87
- passive-interface, 249
- ping, 141-142, 274-276
- recalling, 70

reload, 100
 resume, 138
 router rip, 219, 244
 show cdp neighbors, 119-120
 show controllers
 Layer 1 problems, troubleshooting, 323-324
 show debugging, 131
 show flash, 49
 show hosts, 106
 show interfaces, 95, 317-319
 Layer 1 problems, troubleshooting, 320-321
 Layer 2 problems, troubleshooting, 322-323
 show ip protocols, 329
 show ip route, 96-97, 196, 257, 291-293, 329
 show running-config, 90-91, 96, 109, 181
 show startup-config, 182
 show version, 24, 49-50, 74-75, 155, 175
 show cdp adjacency, 131
 shutdown, 182
 telnet, 106, 133-135
 tftpdnld, 169-171
 traceroute, 142-143
 xmodem, 173

comparing

console and aux ports, 28-29
 design options of RIP versions, 247
 feature sets, 165
 IGPs, 217
 RIPv1 and RIPv2, 243-244
 static and dynamic routes, 296-297
 TCP and UDP, 350
 user EXEC mode and privileged EXEC mode, 43
 versions of CDP, 121

compressed IOS files, 166

config-register command, 173

configuration files

backing up, 106
 with TFTP, 107-109
 backups, storing, 109-110
 copying, 177
 running-config, 176
 editing, 181
 saving, 100
 startup-config, 176
 erasing, 100
 updated command styles, 162-163

configuration modes, 45-46, 63

switching between, 64

configuration register, 57, 154

boot field, 155
 displaying current value, 155
 low-order bits, 155

setting, 154

from ROMMON, 172-173

configure terminal command, 46, 85

configuring

ACLs, 375

access-list command, 375-376

best practices, 379-380

numbered extended, 390-398

numbered standard, 386-390

per direction, 376-377

per interface, 376-377

verifying configuration, 385-386

CDP, 126-128

clock rate on serial interfaces, 88

hostnames, 92

interface descriptions, 103

local host table, 104-106

login banners, 103-104

named IP ACLs, 398-400

passwords, 92-94

RIP, 218-220

neighbors, 249

timers, 248-249

RIPv1, 244-245

RIPv2, 245-247

routers, 85

serial interfaces, 87

static routes, 194

connected routes, 192

connected subnets, 193

connecting

routers to WAN links, 5

to telnet clients, 133-135

connectivity

testing with ping command, 141-142

testing with traceroute command, 142-143

troubleshooting with traceroute command, 326-328

connection establishment/termination, TCP, 343-344

console passwords, 65

console port

accessing, 62

comparing with aux port, 28-29

speed, maximizing, 172

console ports, 24

accessing, 26-27

convergence, 204

on link state routing protocols, 214

copy command, 167

copy startup-config running-config command, 100

copy tftp flash command, 167

copying configuration files

to/from TFTP servers, 177

to/from flash memory, 171

correcting misconfigured routers, 98**cost metric, 199****counting to infinity, 231-233**

split horizon, 233-235

CPE (customer premises equipment), 7**CPU (central processing unit), 13****creating**

back-to-back WAN links, 10-11

initial configuration, 59-60

setup process, 61

network maps with CDP, 128-130

CSU/DSU, 6-7**D**

data link addresses, 358**datagrams, 351****DB-9 connectors, 25****DCE (data circuit-terminating equipment), 7****DDoS attacks, 345****debug cdp events command, 131****debug cdp ip command, 131****debug commands, 331-332**

RIP-related, 254-255

decision logic for IOS image loading, 153

based on boot system commands, 156-158

based on configuration register, 154-156

based on location in flash memory, 158

default routes, 199, 297-298

advertising, 260, 299-301

deny statements, 373**design options, comparing on RIP versions, 247****destination port numbers, 353****DF (don't fragment) bit, 282****dial backup, 197-198****Dijkstra's algorithm, 212****DIMM (dual in-line memory module), 16****directly connected routes, 90, 193****disabling**

ACLs, 377

CDP on an interface, 126

CLI enhanced editing mode, 72

split horizon on RIP, 249

discontiguous networks, 247**discovery process, CDP, 118****displaying**

ACL details, 385

CDP learned information, 123-125

command error messages in CLI, 73-74

configuration register value, 155

interface descriptions, 103

most recent routing updates, 304-305

neighbor router information, 329

router interface status, 319

routing table contents, 291-293, 329

distance vector routing protocols, 207-210, 228

counting to infinity, 231-233

loop avoidance, 241-242

loop prevention

*holddown process, 240-241**holddown timers, 237-238**poison reverse, 235-236**triggered updates, 235-236***RIP***configuring, 218**default route advertisement, 260**design options, 247**floating static routes, 259**neighbors, configuring, 249**RIPv1, configuring, 244-245**RIPv2, configuring, 245-247**route filtering, 251**route redistribution, 249-250**split horizon, disabling, 249**timer, adjusting, 248-249**troubleshooting, 254-255**verifying configuration, 251-254**version migration, 246*

route poisoning, 230-231

routing loop prevention, 282

routing table, displaying most recent routing update, 304-305

split horizon, 233-235

documenting router configuration, 101-102

interface descriptions, 103

login banners, 103-104

DoS attacks, 345

SYN flood attack, 345-346

DTE (data terminal equipment), 8-10**dynamic port numbers, 354****dynamic routes, 12**

versus static routes, 296-297

dynamic routing protocols, 192**dynamic windows, flow control, 341-342**

E

echo replies, 275
echo requests, 275
editing
 commands in CLI, 71-72
 named IP ACLs, 401
 running-config, 181
EGPs (Exterior Gateway Protocols), 205
EIA (Electronic Industries Alliance), 9
EIGRP (Enhanced Interior Gateway Routing Protocol), 217
 metric calculation method, 303
enable mode, 43
enable passwords, 65, 92
enabling CDP on a router, 126-128
equal-cost routes, 305
erase startup-config command, 182
erasing startup-config file, 100
error messages for CLI commands, displaying, 73-74
error recovery, 346
 PAR, 347
Ethernet interfaces, configuring, 87
executive mode, 43
expectational acknowledgments, 347
extended ACLs, 371-372
 numbered, configuring, 390-398
extended pings, 315
external router components, cabling, 19-20

F

failed telnet connections, troubleshooting, 135
fast switching, 256
feature sets, 47, 165
 comparing, 165
features
 of link-state routing protocols, 214
 of TCP and UDP, comparing, 350
fields of IP routing table, 193
file systems, IFS, 161-164
filenames, 164-166
Flash memory, 14
 copying files to/from, 167
 USB flash drives, 49
floating static routes, 199, 259
flooding, 211

flow control, 341
 start/stop, 343
 through dynamic sliding windows, 341-342
 withholding acknowledgments, 343
flush timer (RIP), 248
format of ICMP unreachable messages, 281
forward acknowledgments, 347
fragments, 281
Frame Relay, 9
full updates, 230

G–H

gateway of last resort, 297-299
gateways, 205
granted window, 342

HDLC (High-Level Data Link Control), 9
header fields
 TCP, 351-352
 UDP, 352
history buffer, 70
holddown process, 240-241
holddown timer, adjusting, 248
holddown timers, 237-238
holdtime timer(CDP), 121
hop count, 199, 208, 217
host keyword, 383
host requirements for IP routing process, 277-278
hostname, 64
 configuring, 92
HyperTerminal, 63

I–J

IANA (Internet Assigned Numbers Authority), 355
ICMP (Internet Control Message Protocol), 274
 echo replies, 275
 echo requests, 275
 unreachable messages, 276, 279
format, 281
type codes, 280-281, 312
IETF (Internet Engineering Task Force), 9
IFS (Cisco IOS File System), 161-164
IGPs (Interior Gateway Protocols), 205
 comparing, 217

IGRP (Interior Gateway Routing Protocol), 217

- metric calculation method, 303

images

- feature sets, 47
- loading process, troubleshooting, 160-161
- loading, decision logic, 153
 - based on boot system commands, 156-158*
 - based on configuration register, 154-156*
 - based on location in flash memory, 158*
- locating on TFTP server, 159
- managing, 166
- verifying, 174

implicit deny logic, 374**in-order delivery, 348****inbound filtering, 369-371****infinite metric, 217****initial router booting, 52-53****installing back-to-back WAN links, 10-11****interface configuration mode, 46****interfaces, 120**

- ACLs, applying, 376-377
- descriptions, configuring, 103
- LEDS, 53
- status, displaying with show interfaces command, 319

internal router components, 15-17**IOS images, 47**

- feature sets, 47
- loading process
 - decision logic, 153-158*
 - troubleshooting, 160-161*
- locating on TFTP server, 159
- managing, 166
- verifying, 174

IP addresses, 357**ip default-network command, advertising**

- default routes, 300-301

IP packets, TTL field, 282-283**ip route command, 195****IP routing, 215-216, 277**

- from Layer 3 perspective, 293-294
- host requirements, 277-278
- Layer 2 participation in, 294-295

IP routing table. *See* routing table**ISDN (Integrated Services Digital Network), 9****ISO (International Organization for Standardization), 9****ITU (International Telecommunications Union), 9****L****Layer 1, troubleshooting, 309-310**

- with cdp command, 324-325
- with show controllers command, 323-324
- with show interfaces command, 320-321

Layer 2, 310-311

- IP routing process participation, 294-295
- troubleshooting
 - with show interfaces command, 322-323*
 - with cdp command, 324-325*

Layer 3

- connectivity, testing
 - with ping command, 141-142*
 - with traceroute command, 142-143*
- IP routing process participation, 293-294
- troubleshooting, 311-315

Layer 7, troubleshooting, 315-316**learned CDP information, viewing, 123, 125****leased lines, 6, 10**

- cabling, 21-22

leaves, 213**LEDs, 53****limited-function operating systems, loading, 159****limiting maximum number of telnet connections, 140****line protocol status, 319****link cost, 217****link LSAs, 211****link-state routing protocols, 210-211**

- convergence, 214

load balancing, 256

- unequal cost, 306

loading limited-function operating systems, 159**local host table, configuring, 104, 106****locating**

- command options in CLI, 68-70
- commands in CLI, 67-68
- IOS images on TFTP servers, 159

log messages, 331**logical addressing, 12****login banners, configuring, 103-104****login command, 94****loop avoidance, 241-242. *See also* loop prevention**

- split horizon, 230

loop prevention

- holddown process, 240-241
- holddown timers, 237-238
- poison reverse, 235-236

split horizon, 233, 235
 triggered updates, 235-236
 TTL field, 282-283

lost passwords, recovering, 182

low-order bits, 155

LSAs (link state advertisements), 211

LSDB (link state database), 213

M

MAC addresses, 357

management ports, 24

aux ports, cabling, 28
 comparing, 28-29
 console port
 accessing, 26-27, 62
 maximizing speed of, 172
 passwords, configuring, 92-94

managing Cisco IOS images, 166

mapping network devices with CDP, 128-130

matching criteria, ACLs, 373-375

any/host keywords, 383

matching IP address ranges with wildcard masks, 380-381

complexity of, 382
 keywords, 383

mathematical trees, root, 213

messages, CDP encapsulation, 120

metrics, 12, 208, 217, 230

best path selection, 302-303
 cost, 199
 equal-cost routes, 305
 hop count, 199
 infinite, 217

minimum router configuration requirements, 45

misconfiguration, correcting, 98

modes, 43

modifying ACL configuration, 378-379

MOTD (message of the day) banners, configuring, 103-104

MSS (maximum segment size), 348

MTU (maximum transmission unit), 281

multiple statement processing on ACLs, 373-374

multiplexing, 354

N

named IP ACLs

configuring, 398-400
 editing, 401

neighboring discovered devices, displaying CDP

 learned information, 123-125

neighbor discovery with CDP, 118

neighbors, 204

 displaying information about, 329
 RIP configuration, 249

network command, 219, 244

network maps, creating with CDP, 128-130

no shutdown command, 181

no-ip domain-lookup command, 136

normal pings, 315

numbered ACLs

 extended numbered ACLs, configuring, 390-398
 numbered standard ACLs, configuring, 386-390

NVRAM (nonvolatile RAM), 14

O

octets, 342

operating environments

 boot ROM software, 51
 ROMMON, 51
 configuration register, setting, 172-173
 ftpdnld command, 169-171

operating systems, Cisco IOS. *See* Cisco IOS software

operational status, verifying with show commands, 95-97

OSI reference model

 Layer 1, troubleshooting tips, 309-310
 Layer 2
 IP routing process participation, 294-295
 troubleshooting tips, 310-311
 Layer 3
 IP routing process participation, 293-294
 troubleshooting, 311-315
 Layer 7, troubleshooting, 315-316
 layer functionality, verifying, 132

OSPF (Open Shortest Path First), link cost, 217

out-of-band management, 28

outbound filtering, 369-371

P

packet filtering, ACLs. *See* ACLs

packet switching, 23

packet fragments, 281

PAR (Positive Acknowledgment with Retransmission), 347

partial updates, 217, 230

passive-interface command, 249

passwords, 65

- configuring, 66, 92, 94
- enable mode, 92
- recovering, 51, 182

pasting text into Terminal Emulator window, 178**path selection, 12, 203****PCs, router access methods, 41****periodic full routing updates, 208****permit statements, 373****physical connectivity, troubleshooting, 309-310****physical media, troubleshooting, 310-311****ping command, 141-142, 274-276**

- OSI model layer functionality, testing, 132
- Layer 3 problems, troubleshooting, 311-315

placing ACLs, 402-403**platforms, 47****point-to-point WAN links, 6**

- CSU/DSU, 6-7
- serial cables, 7-8
- serial interfaces, 8

poison reverse, 235-236**populating IP routing table, 295****port numbers, 353, 358**

- functions of, 356-357
- well-known ports, 354

ports, 120

- management ports, 24

POST (power-on self test), 54**PPP (Point-to-Point Protocol), 9****prefix notation, 196****preventing routing loops, 228****privileged EXEC mode, 43****process switching, 256****PSNs (packet-switched networks), 23**

R**RAM (random access memory), 13**

- determining minimum Cisco IOS software requirements, 50

RBOCs (regional Bell operating companies), 7**recalling commands, 70****recovering lost passwords, 182****redundancy, dial backup, 197-198****registered port numbers, 356****reload command, 100****remote telnet connections**

- creating, 133-135
- restricting maximum number of, 140
- suspending, 136-140
- switching between, 138-140
- troubleshooting, 135

restricting maximum number of telnet connections, 140**resume command, 138****resuming suspended telnet connections, 138-140****RIP (Routing Information Protocol), 204**

- configuring, 218-220
- default routes, advertising, 299-301
- neighbors, configuring, 249

RIPv1

- configuring, 244-245*
- design options, 247*
- versus RIPv2, 243-244*

RIPv2

- configuring, 245-247*
- design options, 247*
- route filtering, 251
- route redistribution, 249-250
- split horizon, disabling, 249
- static routes
 - default route advertisement, 260*
 - floating static routes, 259*
- timers, adjusting, 248-249
- troubleshooting, 254-255
- verifying configuration, 251-254
- version migration, 246

ROM (read-only memory), 13**ROMMON (ROM Monitor), 51**

- configuration register, setting, 172-173
- password recovery, 51
- tftpdnld command, 169-171

root, 213**route filtering, 251****route poisoning, 230-231****route redistribution, 249-250****routed protocols, 203****router configuration**

- boot process, 52-53
 - bootstrap program, loading, 54*
 - Cisco IOS, loading, 56-57*
 - LED indicators, 53*
 - POST, 54*
 - startup configuration, loading, 58-59*

CLI

- command options, locating, 68-70*
- commands, locating, 67-68*

- commands, recalling, 70*
- editing mode, 71-72*
- error messages, 73-74*
- console port, accessing, 62
- initial configuration, creating, 59-61
- passwords, 65-66

router LSAs, 211**router rip command, 219, 244****routers**

- cabling, 19-20
- components of, 14-17
- functions of, 215-216
- management ports, 24

routing, 12**routing algorithms, SPF, 212****routing loop avoidance. *See* loop avoidance****routing loop prevention. *See* loop prevention****routing protocol configuration mode, 46****routing protocols, 203**

- algorithms, 206
- classful, 261-262
- classless, 261-262
- distance vector. *See* distance vector routing protocols
- functions of, 203-205
- metrics
 - best path selection, 302-303*
 - equal-cost routes, 305*

routing table, 192, 228

- administrative distance, 301-302
- contents, displaying, 291-293, 329
- default routes, 297-299
 - advertising, 299-301*
- fields, 193
- populating, 295
- routing updates, viewing most recent, 304-305

routing updates, 217**RS-232, 27****running-config, 176**

- backing up, 106
 - with TFTP, 107-109*
- copying, 177
- editing, 181

S**saving configuration files, 100****segmentation (TCP), 349****segments, 351****selecting**

- ACL locations, 402-403
- appropriate Cisco IOS Software, 156
- subnet masks to apply to ACLs, 384

serial cables, 7

- synchronization, 8

serial interfaces, 8

- asynchronous, 22
- configuring, 87

serial link clock rate, configuring, 88**service providers, 7****setting the configuration register, 154****setup process, 61****show cdp adjacency command, 131****show cdp neighbors command, 119-120****show commands**

- RIP-related, verifying RIP configuration, 251-254
- verifying operational status, 95-97

show controllers command, troubleshooting Layer 1 problems, 323-324**show debugging command, 131****show flash command, 49****show hosts command, 106****show interfaces command, 95, 317-318**

- Layer 1 problems, troubleshooting, 320-321
- Layer 2 problems, troubleshooting, 322-323
- routing interface status, displaying, 319

show ip protocols command, 329**show ip route command, 96-97, 196, 257, 291-293, 329**

- displaying routing table contents, 291-293

show running-config command, 90-91, 96, 109, 181**show startup-config command, 182****show version command, 24, 49-50, 74-75, 154-155, 175****shutdown command, 182****SIMM (single in-line memory module), 16****smart serial interfaces, 19****sockets, 358****SPF algorithm, 212****split horizon, 230, 233-235**

- disabling, 249

standards bodies

- EIA, 9
- IETF, 9
- ISO, 9

start/stop flow control, 343

startup configuration, 176

- backing up, 106
 - with TFTP, 107-109
- copying, 177
- erasing, 100
- loading, 58-59

static routes, 12, 192-194. See also default routes

- default route advertisement, 260
- administrative distance, 198-199
- floating static routes, 199, 259
- verifying, 201-202
- versus dynamic routes, 296-297

storing backup configuration files, 109-110**structured troubleshooting method,
applying to problems, 307-309****subconfiguration modes (Cisco IOS), 86****subnets**

- connected, 193
- directly connected routes, 90

suspending telnet connections, 136-140**switching**

- between configuration modes, 64
- between multiple telnet connections, 138-140

symptoms

- of Layer 1 problems, 320-321
- of Layer 2 problems, 322-323

SYN flags, 344**SYN flood attacks, 345-346****synchronization, 8****syntax for command input, 87****T**

TAC (Technical Assistance Center), 55**TCP (Transmission Control Protocol)**

- Acknowledgment Number field, 347
- connection establishment/termination, 343-344
- DoS attacks, SYN flood attacks, 345-346
- error recovery, 346
- features of, 340-341
- flow control, 341
 - through dynamic sliding windows, 341-342
 - withholding acknowledgments, 343
- header fields, 351-352
- in-order delivery, 348
- multiplexing, 354
- octets, 342
- port numbers, 353
 - functions of, 356-357
 - well-known ports, 354
- segmentation, 349

- sockets, 358
- versus UDP, 350

telcos

- leased lines, 10
- point-to-point WAN links, 6
 - CSU/DSU, 6-7
 - serial cables, 7

telnet command, 106, 133

- troubleshooting Layer 7 problems, 315-316

telnet connections, 132

- failed connections, troubleshooting, 135
- restricting maximum number of, 140
- suspending, 136-140
- switching between, 138-140

terminal emulator software, 24

- configuration files, backing up, 109
- HyperTerminal, 63
- Text Capture feature, 179
- text, pasting into, 178

terminal history feature (CLI), 70**testing OSI model layer functionality, 132****text editors, 177****TFTP (Trivial File Transport Protocol), backing up
configuration files, 107-109****TFTP servers, copying to/from, 177****tftpdnld command, 169-171****three-way handshakes, 343-344****timers**

- CDP, 121-123
- RIP, adjusting, 248-249

TLVs (Type Length Value), 120**traceroute command, 142-143**

- connectivity, troubleshooting, 326-328

transport layer protocols

- functions of, 340
- TCP. *See* TCP
- UDP. *See* UDP

triggered updates, 235-236**troubleshooting**

- connectivity problems with traceroute command, 326-328
- failed telnet connections, 135
- image loading process, 160-161
- Layer 1 problems, 309-310
 - with cdp command, 324-325
 - with show controllers command, 323-324
 - with show interfaces command, 320-321
- Layer 2 problems, 310-311
 - with cdp command, 324-325
 - with show interfaces command, 322-323

Layer 3 problems, 311-315
 Layer 7 problems, 315-316
 RIP, 254-255
 structured methodology, 307
 with debug command, 331-332

TTL (Time to Live) field, 282-283

type codes, ICMP unreachable messages, 280-281

U

UDP (User Datagram Protocol)

datagrams, 351
 features of, 340-341
 header fields, 352
 port numbers, 353
 functions of, 356-357
 well-known ports, 354
 sockets, 358
 versus TCP, 350

unequal-cost load balancing, 306

unreachable messages (ICMP), 276-279

format, 281
 type code 4, 280-281, 312

update interval (CDP), 121

updated configuration file command styles, 162-163

USB (Universal Serial Bus) connectors, 25

flash drives, 49

user mode EXEC mode, comparing with privileged EXEC mode, 43

V

vectors, 210

verifying

ACLs, 385-386
 CDP operations, 125-128
 Cisco IOS images, 174
 Layer 3 connectivity, 141-143
 operational status with show commands, 95-97
 OSI model layer functionality, 132
 Layer 3 connectivity, 142-143
 RIP configuration with show commands, 251-254
 static routes, 201-202

version migration (RIP), 246

versions of CDP, 121

viewing

interface descriptions, 103
 learned CDP information, 123-125

W

WANs, 5

back-to-back links, installing, 10
 circuit-switched, 22-23
 leased lines
 cabling, 21-22
 packet-switched, 23
 point-to-point links, 6
 CSU/DSU, 6-7
 serial cables, 7
 serial interfaces, 8
 routing, 3

well-known ports, 354-356

wildcard masks, 380-381

selecting, 384
 keywords, 383
 potential complexity of, 382

windows, 341

X-Y-Z

xmodem command, 173

Xmodem protocol, copying files to/from flash memory, 171