

INDEX

Numerics

- 10 GbE, 112–113
 - PMD types, 113
 - switch compatibility listing, website, 113
- 10 Gigabit Ethernet Alliance, 112
- 10 Mbps Ethernet, 107–108
- 10/100 ports, 109
- 10/100/1000 ports, 112
- 20/80 rule, 19, 140
- 80/20 rule, 18, 140
- 802, 298
- 802.1Q. See IEEE 802.1Q
- 802.1x, configuring, 439

A

- AAA**
 - accounting, enabling on Catalyst switches, 435–436
 - authentication, enabling on Catalyst switches, 431–433
 - authorization, enabling on Catalyst switches, 434–435
- access layers, 21
- accessing trunks with switch spoofing, 466–467
- accounting, enabling on Catalyst switches, 435–436
- aCEF (Accelerated CEF), 319
- ACLs, 64. *See also* VACLs
- active STP features, verifying on switch ports, 274
- adding text descriptions to switch ports, 118
- addressing, multicast, 376
 - OUI values, 376
 - reserved addresses, 377
- adjacency tables, 319–321
 - contents, displaying, 320
 - discard adjacencies, 322
 - drop adjacency, 321
 - null adjacencies, 321
 - punt adjacencies, 322
- adjacent hosts, 317
- administratively scoped addresses, 377
- advertisements, VTP, 161–163
 - requests, 164
 - subset adv, 164
- subset advertisements, 164
- summary advertisements, 163
- aggressive mode (UDLD), 272
- alternate port, on RSTP topology, 284
- ANSI (American National Standards Institute)
 - X3T11 FibreChannel, 111
- answers to scenarios
 - scenario 1, 494
 - scenario 2, 494–495
 - scenario 3, 495
 - scenario 4, 496
 - scenario 5, 497
 - scenario 6, 498–499
 - scenario 7, 499
 - scenario 8, 499–500
 - scenario 9, 500–502
- application-specific integrated circuits (ASICs), 10
- applying, VACLs to VLAN interfaces, 460
- ARP
 - inspection, configuring, 443–446
 - throttling, 321
- ASICs (application-specific integrated circuits), 10
- assessing
 - current traffic patterns, 47
 - interface data rates, 46–47
- assigning
 - descriptions to switch ports, 118
 - switch ports to VLANs, 138
- associating, secondary VLANs to primary VLAN SVI, 465
- attributes, core devices, 22
- authentication
 - enabling on Catalyst switches, 431–433
 - MD5, 341
 - port-based, configuring, 439–441
- authorization, enabling on Catalyst switches, 434–435
- automatically configuring STP timers, 251–252
- autonegotiation, 109, 112
- Auto-RP, 385
- autosensing, on Catalyst switches, 114
- AVF (active virtual forwarder), 351–353
- AVG (active virtual gateway), 350–351

B

baby giant frames, 145
BackboneFast, 256–257
backup port, on RSTP topology, 284
best effort QoS, 412
best practices, securing Catalyst switches, 446–449
Blocking state (STP), 217
block core, 36–38
bootstrap router methods, 385
BPDU Guard, 268–269
BPDUs
 BPDU Guard, 268–269
 Configuration BPDUs, 209–210
 convergence, 287
 filtering, 274
 MST, 294
 protecting against sudden loss, 270
 Root Guard, 267–268
 RSTP, 285
 TCN BPDUs, 220
Bridge IDs, 211
bridging
 loops, preventing, 207–209
 transparent
 redundancy, 207
 versus Ethernet switches, 205–206
broadcast domains, 14, 135
broadcast storms, 208
broadcast traffic, 375
BSR (bootstrap router), 386
building access switches, 21
building block model
 enterprise edge block, 40–41
 network management block, 40
 server farm block, 39–40
 service provider edge block, 41–42
bundled ports (EtherChannel), 184
bundles
 distributed EtherChannel traffic, 184–185
 troubleshooting, 191–194

C

cabling
 Category 5 crossover cables, 115
 connecting to switch console port, 114
 Ethernet, distance limitations, 108
 Fast Ethernet specifications, 109
calculating, Root Path Cost, 213
CAM (Content Addressable Memory) tables, 64, 69–70
 duplicate entries, handling, 70
 entries, viewing, 74
 stale entries, 69
 static entries, configuring, 69
 troubleshooting, 75
campus networks
 building block
 enterprise edge block, 40–41
 network management block, 40
 server farm block, 39–40
 service provider edge block, 41–42
 LAN segmentation model, 15, 17
models, 13
modular designs, 31
 core block, 35–39
 switch block, 32–35
network traffic models, 18–19
predictable network model, 19–20
shared network model, 13–14
campus-wide VLANs, deploying, 140
canonical format, 145
Catalyst switches
 autosensing, 114
 CDP, 89
 Fast Ethernet ports, 114
file management, 90
 configuration files, 91–92
 image files, 90–91
 moving files, 92–94
files systems, 90
NSF configuring, 363
port security, 436–439
PortFast feature, 225
ports, configuring, 116
power supply redundancy, configuring, 363–365
redundancy modes, 359–361

- remote access, 88–89
- securing, best practices, 446–449
- SPAN, 470
 - local SPAN, 471–474
 - RSPAN, 474–476
 - VSPAN, 471–474
- supervisor synchronization, configuring, 362
- Category 5 crossover cables, 115
- CatOS, 85
 - host name, changing, 86
 - passwords, 87–88
 - troubleshooting, 95–96
- cd flash command, 93
- CDP (Cisco Discovery Protocol), 43
 - discovering network topology, 43–46
 - inter-switch communication, 89
 - viewing neighboring device information, 96–97
- cdp enable command, 89
- CEF (Cisco Express Forwarding), 66, 315. See also
 - fallback bridging
 - adjacency table, 319–321
 - configuring, 323
 - FIB, 316, 319
 - glean state, ARP throttling, 321
 - packet rewrites, 322–323
 - process switching, 68
 - verifying, 327–328
- CFI (Canonical Format Indicator), 145
- CGMP (Cisco Group Membership Protocol), 387–388
- channel-protocol command, 189
- Cisco IOS Software, 85–87
- Cisco IP Phones
 - inline power, 403–405
 - PoE, 401
 - configuring, 404
 - powered device detection, 402–404
 - verifying power status, 405
 - trunking modes, 407
- classification, 416–417
- client mode (VTP), 162, 167
- collapsed core block, 36–37
- collisions
 - domain, 13
 - preventing, 15
- commands
 - cd flahs, 93
 - cdp enable, 89
 - channel-protocol, 189
 - copy flash, 93
 - debug commands, 96
 - debug spanning-tree switch state, 218
 - delete flash, 93
 - dir, 93
 - erase flash, 93
 - errdisable detect cause, 120
 - format flash, 93
 - interface range, 117
 - lacp port-priority, 191
 - name, 138
 - no shutdown, 314
 - show, output, filtering, 95
 - show adjacency summary, 320
 - show cdp neighbors detail, 45
 - show commands, troubleshooting, 95
 - show etherchannel load-balance, 194
 - show etherchannel port, 192
 - show etherchannel port-channel, 187
 - show etherchannel summary, 192
 - show glbp, 356
 - show interface, 121, 173
 - show interface status, 325
 - show interface trunk, 151–152
 - show interfaces switchport, 151
 - show ip cef, 317
 - show ip interface, 326
 - show ip interface brief, 327
 - show lacp sys-id, 194
 - show mac address-table, 74
 - show port-security interface, 438–439
 - show power, 365
 - show spanning-tree interface, 218, 249
 - show spanning-tree vlan, 252, 291
 - show vlan, 138, 325
 - show vlan id, 150
 - show vpt counters, 169
 - show vtp, 173
 - show vtp status, 165, 169
 - shutdown, 121, 325
 - spanning-tree guard loop, 271
 - spanning-tree guard root, 268
 - spanning-tree portfast, 290

- speed, 119
- switchport, 138, 146, 312–313
- udld, 272
- vtp mode transparent, 137
- community VLANs, 461
- comparing
 - Ethernet switches, 205–206
 - STP switch ports, roles versus states, 284
 - transparent bridges, 205–206
- conceding, HSRP router election, 341–342
- Configuration BPDUs, 209–210
- configuring
 - ARP inspection, 443–446
 - BackboneFast, 256–257
 - Catalyst switch
 - redundancy mode, 360–361
 - supervisor synchronization, 362
 - CEF, 323
 - DHCP snooping, 441–443
 - dual core block, 38
 - EtherChannel, 189
 - LACP, 190
 - load balancing, 186–187
 - PAgP, 189
 - Ethernet switch ports, 110
 - fallback bridging, 324
 - files, 90–93
 - interVLAN routing, 312
 - Layer 2 ports, 312
 - Layer 3 ports, 313–314
 - SVI ports, 314
 - LACP EtherChannel, 190–191
 - modular network designs, 31
 - MST, 297–298
 - NSF on Catalyst switches, 363
 - PAgP negotiation, 189–190
 - PIM, dense mode, 382
 - PIM-SM, 384
 - PoE, 404
 - port security, Catalyst switches, 436–439
 - port-based authentication, 439–440
 - PortFast, 253–254
 - power supply redundancy, Catalyst switches, 363–365
 - PVLANs, 462–465
 - QoS, trust, 418–420
 - RPVST+, 291–292
 - RSPAN, 475–476
 - RSTP, 290
 - static CAM table entries, 69
 - static VLANs, 137–138
 - STP
 - network diameter value, 220
 - Root Bridge, 243–246
 - timers, 250–251
 - UDLD, 273
 - switch ports, 116–119
 - UDLD, message interval, 272
 - VACLs, 459–460
 - VLAN trunks, 146–149
 - voice VLANs, 407–409
 - VRRP, 348
 - VTP, 165
 - client mode, 167
 - example configuration, 169
 - management domains, 166
 - pruning, 172
 - server mode, 166
 - transparent mode, 167
 - version, 167–168
 - congestion
 - 80/20 rule, 18
 - relieving, 13
 - connecting, 114–116
 - to console ports, 114
 - switch block devices, 114–115
 - connectivity
 - core block, 36–38
 - logical, 135
 - switch ports, troubleshooting, 122–123
 - connectors, GbE, 115–116
 - consistency checks, VTP version 2, 168
 - console ports, 114
 - convergence
 - controlling on STP
 - BackboneFast, 256
 - PortFast, 253
 - UplinkFast, 254–255
 - RSTP, 287
 - port types, 286
 - topology, 285–288

STP timers, 219
TCN BPDUs, 220
copy flash command, 93
copying, running-config files to startup-config, 94
core block, 31, 35–38
 collapsed core, 36–37
 dual core, 37–39
 scaling, 39
core layer, 22
crashinfo file, 92
criteria for process switching, 68
crossover cables, Category 5, 115
CSMA/CD (carrier sense multiple access collision detect), 107
CST (Common Spanning Tree), 226
current traffic patterns, assessing, 47
customizing, STP
 Port ID, 248–249
 Root Path Cost, 247–248
 timers, 250–251

D

DAI (dynamic ARP inspection), 444
dCEF (Distributed CEF), 319
debug commands, troubleshooting CatOS, 96
debug spanning-tree, switch state command, 218
decision processes, MLS packet forwarding, 66–68
defining
 MST regions, 297–298
 VACL matching conditions, 459–460
Delay, 411
delete flash command, 93
deleting
 SPAN sessions, 472
 VLANs from switch ports, 138
demand-based switching, 65
Dense Mode (PIM), 381–382
deploying VLANs, 139–140
descriptions, adding to switch ports, 118
Designated Ports
 election procedure, 215–216
 RSTP topology, 284
 selection of, 216–217

designing
campus networks, 40
 enterprise edge block, 40–41
 network management block, 40
 predictable network model, 19–20
 server farm block, 39
 service provider edge block, 41–42
enterprise networks, evaluating existing network, 42–47
hierarchical networks
 access layer, 21
 core layer, 22
 devices, 22
 distribution layer, 21
detecting
 duplex mode mismatches on links, 122–123
 switch port error conditions, 119–120
devices
 distribution layers, 21
 hierarchical network design, 22
 Layer 2 switching, 10
 Layer 3 routing, 11
 Layer 3 switching, 11
 Layer 4 switching, 12
 MLS (multilayer switching), 12
DHCP snooping, configuring, 441–443
DiffServ
 packet classification, 416–417
 QoS model, 412–413
 Layer 2 classification, 413
 Layer 3 classification, 414–416
 trust boundaries, 417
dir command, 93
direct topology changes, 221–222
directories, crashinfo, 92
Disabled state (STP), 217
disabling
 DTP, 148
 STP with BPDU filtering, 274
discard adjacencies, 322
discovering, network topology, 43–47
displaying
 active EtherChannel parameters on port, 193
 adjacency table contents, 320
 CAM table entries, 74
 CDP information, 96–97

detailed GLBP configuration information, 357–358
 file system contents, 95
 port configuration, 193
 port status, 438
 PortFast status, 254
 STP information, 257
 switch ports
 speed, 121
 root-inconsistent state, 268
 trunking status, 148
 UpLinkFast status, 255
 VRRP status information, 348
 VTP management domain parameters, 169–170
 distribution layer, 21, 36
 don't care bits, 72
 double tagging, 143–144, 414
 drop adjacencies, 321
 DSCP, Layer 3 QoS classification, 414–415
 DTP (Dynamic Trunking Protocol), 145–148
 dual cores, 37–39
 dual-homing, 39
 duplex autonegotiation, 110
 duplex mode
 link mismatches, detecting, 122–123
 switch port configuration, 119
 duplicate CAM table entries, handling, 70
 dynamic auto trunking mode, 147
 dynamic desirable trunking mode, 147
 dynamic VLANs, 139

E

EAPOL (Extensible Authentication Protocol over LAN), 439–441
 edge ports, RSTP, 286, 290
 EF (Expedited Forwarding), 416
 election processes
 Designated Ports, 215–216
 Root Bridges, 211–212
 Root Ports, 212–214
 enable mode (CatOS), 86
 enabling
 BPDU guard as default, 269
 GLBP, 354–357

loop guard as default, 271
 MST, 297–298
 PortFast, 290
 root guard, 268
 UDLD, 272
 VTP pruning, 172
 end-to-end VLANs, deploying, 140
 enterprise composite network model
 core block, 35–36
 collapsed core block, 36–37
 dual core block, 37–38
 enterprise edge block, 40–41
 network management block, 40
 server farm block, 39
 service provider edge block, 41–42
 switch block, 32–33
 distribution layer, 33
 sizing, 33–35
 enterprise edge block, 31, 40–41
 enterprise networks, designing, 42–47
 erase flash command, 93
 erasing startup-config files, 94
 errdisable detect cause command, 120
 errisable state, 269
 EtherChannel, 183
 active parameters, displaying, 193
 bundled ports, 184
 configuring, 189
 hashing algorithm, 184
 LACP, 188–191
 load balancing
 configuring, 186–187
 verifying effectiveness of, 187
 negotiation protocols
 LACP, 188–189
 PAgP, 188–190
 PAgP, 188–189
 redundancy, 184
 traffic distribution, 184–185
 troubleshooting, 191–194
 XOR operation, 184
 Ethernet
 10 Gigabit Ethernet, 112–113
 10 Mbps Ethernet, 107–108
 cabling, distance limitations, 108
 CSMA/CD, 107

Fast Ethernet, 109
 autonegotiation, 110
 backward-compatibility, 109
 cabling specifications, 109
 FEC, 111
 FibreChannel, 111
 full-duplex, 109–111
 full-duplex operation, 108
 GbE, port cables, 115–116
 Gigabit Ethernet, 111–112
 half-duplex operation, 107
 switch block connections, 114–116
 examples
 TCAM tables, 72
 VTP configuration, 169
 exploits, VLAN hopping, 468–469
 extended-range VLANs, 137

F

fallback bridging, 68, 323
 configuring, 324
 verifying, 328
 Fast Ethernet, 109
 autonegotiation, 110
 backward-compatibility, 109
 cabling specifications, 109
 Catalyst switch ports, 114
 FEC, 111
 FibreChannel, 111
 full-duplex, 109, 111
 links, 110
 switch ports, configuring, 110
 FDDI (Fiber Distributed Data Interface), 10
 FEC (Fast EtherChannel), 111, 183
 FIB (Forwarding Information Base), 66, 316–319
 Fiber Distributed Data Interface (FDDI), 10
 FibreChannel, 111
 fields, Configuration BPDUs, 210
 file management, switches, 90
 configuration files, 91–92
 image files, 90–91
 moving files, 92–94
 filtering, show command output, 95
 flat networks, 135

flooding, VTP pruning, 170–172
 format, 164
 format flash command, 93
 Forward Delay timer (STP), 217–219, 250
 forwarding
 frames
 decision processes, 63–65
 Layer 2 switching, 10
 Layer 3 switching, 11
 packets
 Layer 3 routing, 11
 Layer 4 switching, 12
 Forwarding state (STP), 217
 frame identification. See tagging
 frames
 baby giants, 145
 BPDUs
 Configuration BPDUs, 209–210
 TCN BPDUs, 220
 forwarding through Layer 2 switches, 63–65
 Layer 2 switching, 10
 Layer 3 switching, 11
 multicast, 14
 tagging, 144
 unknown unicast, 170, 206
 full-duplex Fast Ethernet, 109–111
 full-duplex operation, 108
 fully, 312
 functionality, switching, 9–12

G

gateway redundancy, 337
 addresses
 GLBP, 350–357
 HSRP, 338–346
 VRRP, 347–348
 verifying, 358
 GbE, port cables, 115–116
 GBIC (Gigabit Interface Converter) modules, 115–116
 GEC (Gigabit EtherChannel), 112, 183
 General Queries (IGMPv2), 380
 Get Nearest Server (GNS), 14
 Gigabit Ethernet, 111–112

GLBP (Gateway Load Balancing Protocol), 350
 AVF, 351–353
 AVG, 350–351
 displaying detailed configuration information, 357–358
 enabling, 354–357
 load balancing, 353
 verifying operation, 356
 glean states, ARP throttling, 321
 globally scoped addresses, 377
 GNS (Get Nearest Server), 14
 Group-Specific Queries (IGMPv2), 380
 GVRP (GARP VLAN Registration Protocol), 157

H

half-duplex operation, 107
 half-duplex ports, RSTP topology, 286
 hardening, Catalyst switches, 446–449
 hardware-based bridging, 10
 hashing algorithm (EtherChannel), 184
 Hello Time interval (RSTP), 285
 Hello Timer (STP), 219, 250
 hierarchical network design, 20
 access layer, 21
 core layer, 22
 devices, 22
 distribution layer, 21
 host mode (switch ports), 461
 host names, changing, 86
 HSRP, 338
 gateway addressing, 342–343
 load, 344
 load balancing, 344–346
 MD5 authentication, 341
 plain-text authentication, 340
 router election, 338–342

I

identifying
 switch ports, 118
 VLAN frames, IEEE 802.1Q, 144
 IEEE 802.1D. See STP (Spanning Tree Protocol)

IEEE 802.1Q, 144, 292, 414
 CST, 226
 native VLAN, 144
 TCI field, 145
 VID, 145
 IEEE 802.1w. See RSTP (Rapid Spanning Tree Protocol)
 IEEE 802.1x, configuring, 439
 IEEE 802.3. See Ethernet
 IEEE 802.3z Gigabit Ethernet, 111–112
 IGMP, 379
 IGMPv1, 379
 IGMPv2, 380
 IGMPv3, 380
 Membership Report messages, 379
 multicast switching, verifying, 389
 snooping, 386–387
 IGMPv3, 380
 image files, 90–91
 implementing, MST, 294
 independence, 285
 indirect failures, STP, 250
 indirect topology changes, 222–224
 inline power. See PoE (Power over Ethernet)
 insignificant topology changes, 224–225
 interface configuration mode (CatOS), 86
 interfaces
 data rates, assessing, 46–47
 range command, 117
 SVIs, 314
 internal tagging, 144
 interoperability, STP and RSTP, 285
 inter-switch communication, 89
 interVLAN routing, 311
 configuring, 312
 interfaces, 312
 Layer 2 ports, configuring, 312
 Layer 3 mode, configuring, 314
 Layer 3 ports, configuring, 313–314
 multilayer switches, interface types, 312
 SVI ports, configuring, 314
 verifying, 324–327
 IntServ QoS model, 412
 IP addressing, VLANs, 139
 IP multicast, 376
 addressing, 376–377

- IGMP, 379
 - IGMPv1, 379
 - IGMPv2, 380
 - IGMPv3, 380
 - multicast trees, 378
 - PIM, 380
 - Dense Mode, 381–382
 - Sparse Mode, 383
 - Sparse-Dense Mode, 384
 - verifying multicast routing, 388
 - Version 1, 385
 - Version 2, 386
 - RPF, 378
 - switching
 - CGMP, 387–388
 - IGMP snooping, 386–387
 - verifying multicast switching, 389
 - IP Telephony
 - Cisco IP Phones
 - inline power, 403
 - PoE, 401–405
 - trunking modes, 407
 - QoS, 410
 - trust, configuring, 418–420
 - verifying, 420
 - voice VLANs, 406
 - configuring, 407–409
 - verifying operation, 409
 - ISL (Inter-Switch Link), 143–144, 414
 - isolated VLANs, 461
 - IST (Internal Spanning Tree), 295
-
- ## J-L
- jitter, 411
 - keywords, CAM table commands, 69
 - LACP (Link Aggregation Control Protocol), 188–191
 - lacp port-priority command, 191
 - LAN PHY, 113
 - LANs
 - campus networks
 - predictable network model, 19–20
 - shared network model, 13–14
 - Ethernet, 107–108
 - 10-Gigabit Ethernet, 112–113
 - cabling, distance limitations, 108
 - CSMA/CD, 107
 - Fast Ethernet, 109–111
 - full-duplex operation, 108
 - Gigabit Ethernet, 111–112
 - half-duplex operation, 107
 - Fast Ethernet, cabling specifications, 109
 - segmentation model, 15–17
 - switching, CAM tables, 70
 - Token Ring, susceptibility to collisions, 13
 - latency, 411
 - Layer 2 ports, interVLAN routing configuration, 312
 - Layer 2 QoS classification, 413
 - Layer 2 switching, 10, 61
 - CAM tables, 69–70
 - entries, viewing, 74
 - stale entries, 69
 - static entries, configuring, 69
 - troubleshooting, 74–75
 - frame processing, 63–65
 - TCAM tables, 70
 - example, 72
 - LOUs, 74
 - port operation, 73
 - structure, 70–71
 - troubleshooting, 75
 - VMR combinations, 71
 - transparent bridging, 61–63
 - Layer 3, MLS, 13
 - Layer 3 engine, 316
 - CEF
 - adjacency table, 319
 - configuring, 323
 - packet rewrites, 322–323
 - FIB, 316–319
 - Layer 3 ports, interVLAN routing configuration, 313–314
 - Layer 3 QoS classification, 414–416
 - Layer 3 routing, 11
 - Layer 3 switching, 11
 - Layer 4 switching, 12
 - layers, 9–12, 21
 - learning state (STP), 217
 - Leave Group messages (IGMPv2), 380
 - limitations
 - extended-range VLANs, 137
 - flat networks, 135

- link-local addresses, 377
 - links
 - duplex mismatches, 110
 - EtherChannel, 183–184
 - mismatched duplex mode, detecting, 122–123
 - speeds, autonegotiation, 110
 - Listening state (STP), 217
 - listings, switch ports in root-inconsistent state, 268
 - load balancing
 - EtherChannel configuration, 186
 - GLBP, 353
 - HSRP, 344–346
 - local VLANs, deploying, 140
 - logical addressing, 11
 - logical connectivity, 135
 - login passwords, user EXEC mode, 87
 - loop avoidance, STP, 270
 - BPDU Guard, 268–269
 - loop guard, 271
 - Root Guard, 267–268
 - troubleshooting, 274
 - UDLD, 271–273
 - loop guards, 270–271
 - enabling as default, 271
 - ports, loop-inconsistent state, 270
 - loop-inconsistent state, 270
 - loss, 411
 - lost passwords, recovering, 88
 - LOUs (Logical Operation Units), 74
-
- ## M
- management, 166
 - block, 31
 - configuring, 166
 - domains, 161
 - advertisement process, 162–164
 - configuring, 166
 - parameters, displaying, 169–170
 - viewing status, 169
 - VTP advertisement, 162–163
 - manipulating switch configuration files, 93
 - manually configuring STP timers, 250–251
 - mapping
 - VLANs to multiple STP instances, 294–295
 - IST, 295
 - MSTIs, 296–297
 - promiscuous mode ports, PVLAN
 - configuration, 464
 - matching conditions, VACLs defining, 459–460
 - MaxAge timer (STP), 219, 250
 - MD5 authentication, 341
 - membership methods, port-based VLANs, 136
 - Membership Report messages, 379
 - messages
 - IGMP Membership Report, 379
 - interval, UDLD configuring, 272
 - TC (topology change), 289
 - method lists, 802.1x port-based authentication, 440
 - migrating spoofing attacks
 - ARP inspection, 443–446
 - DHCP snooping, 441–443
 - migrating hierarchical network design, 47–50
 - mismatched duplex/speed on ports, monitoring, 122–123
 - MLS
 - CAM tables, 69–70
 - duplicate entries, handling, 70
 - entries, viewing, 74
 - stale entries, 69
 - static entries, configuring, 69
 - troubleshooting, 74–75
 - CEF, 66, 315
 - adjacency table, 319–321
 - configuring, 323
 - FIB, 316, 319
 - glean state, 321
 - packet rewrites, 322–323
 - verifying, 327–328
 - interVLAN routing
 - configuring, 312–314
 - interfaces, 312
 - verifying, 324–327
 - packet forwarding, exceptions for, 68
 - packet processing, 66–68
 - route-caching, 65
 - TCAM tables, 70
 - example, 72
 - LOUs, 74
 - port operations, 73
 - structure, 70–71
 - troubleshooting, 75
 - VMR combinations, 71
 - topology-based, 65
 - MLS (multilayer switching), 12, 65–68

- models, campus networks, 13
- modifying STP timers, 250–251
- modular network designs, 31
 - core block, 35–36
 - collapsed core, 36–37
 - dual core, 37–39
 - migrating to, 48–50
 - switch block, 32–33
 - distribution layer, 33
 - sizing, 33–35
- monitoring
 - port speed/duplex mismatches, 122–123
 - switch ports with SPAN, 470
 - local SPAN, 470–474
 - RSPAN, 474–476
 - VSPAN, 471–474
- moving files, 92–94
- MST (Multiple Spanning Tree), 293–294
 - configuring, 297–298
 - IST instances, 295
 - MST instances, 296
 - regions, 294
- MSTIs (Multiple Spanning Tree instances), 296–297
- MT-RJ connectors, 114
- multicast, 375
 - addressing, 376
 - OUI values, 376
 - reserved addresses, 377
 - frames, 14
 - flows, 383
 - groups, 375
 - PIM, 380
 - Dense Mode, 381–382
 - Sparse Mode, 383
 - Sparse-Dense Mode, 384
 - verifying multicast routing, 388
 - version 1, 385
 - version 2, 386
 - routing
 - IGMP, 379–380
 - multicast trees, 378
 - RPF, 378
 - switching
 - CGMP, 387–388
 - IGMP snooping, 386–387
 - verifying, 389
- traffic, 14, 381
- trees, 378
- verifying multicast switching, 389
- multilayer switching (MLS), 12
 - CEF, 315
 - interface types, 312
 - interVLAN routing
 - configuring, 312
 - Layer 2 ports, configuring, 312
 - Layer 3 ports, configuring, 313–314
 - SVI ports, configuring, 314
 - router redundancy, 337
 - GLBP, 350–357
 - HSRP, 338–346
 - VRRP, 347–348

N

-
- name command, 138
 - native VLAN, 144
 - negotiation protocols (EtherChannel)
 - LACP, 188–191
 - PAgP, 188–190
 - NetFlow LAN switching, 65, 315
 - networks
 - campus
 - models, 13
 - modular designs, 31
 - diameter value, configuring, 220
 - distribution layer, 21
 - management block, 40
 - switching functionality, 9–12
 - topology, discovering, 43–47
 - traffic models, 18–19
 - no shutdown command, 314
 - nonedge, 287
 - Normal mode (UDLD), 272
 - NSF (non-stop forwarding), configuring on Catalyst switches, 363
 - null adjacencies, 321
 - NVRAM, startup configuration, 87

O-P

- one-armed router, 311
- operating systems, 85–86
- OUI (Organizationally Unique Identifier) values, 376
- packets
 - classification, 416–417
 - filtering, VACLs, 459–460
 - forwarding, 337
 - Layer 3 routing, 11
 - Layer 4 switching, 12
 - processing through multilayer switches, 66–68
 - rewrites, 322–323
- PAgP (Port Aggregation Protocol), 188
 - configuring, 189–190
 - silent submode, 190
- parameters, VTP management domains, displaying, 169–170
- passwords, CatOS, 87–88
- Path Costs, 213
- PDU (protocol data unit), 9
- physical connectivity, 135
- PIM (Protocol Independent Multicast), 380
 - Dense Mode, 381–382
 - Sparse Mode, 383
 - Sparse-Dense Mode, 384
 - verifying multicast routing, 388
 - Version 1, 385
 - Version 2, 386
- PIM-SM, configuring, 384
- plain-text HSRP authentication, 340
- PMD (Physical Media Dependent) interfaces, 113
- PoE (Power over Ethernet), 401
 - configuring, 404
 - power status, verifying, 405
 - powered device detection, 402–404
- point-to-point links (RSTP), 290
- point-to-point ports (RSTP), 286
- Port ID, tuning, 248–249
- port-based authentication
 - 802.1x method lists, 440
 - configuring, 439–441
- port-based membership, static VLANs, 136
- port-based VLAN membership, 136–138
- PortFast, 225, 253
 - configuring, 253–254
 - enabling, 290
 - status, displaying, 254
- ports
 - active EtherChannel parameters, displaying, 193
 - BPDU filtering, enabling, 274
 - cables, GbE, 115–116
 - compatibility errors (EtherChannel), troubleshooting, 194
 - duplex mode, configuring, 119
 - Fast Ethernet, Catalyst switches, 114
 - operations, TCAM tables, 73
 - priority value, 188
 - roles
 - assigned in Root Guard, 267
 - versus states, 284
 - RSTP, roles, 286
 - security, 436–439
 - selecting as ranges, 117
 - speed/duplex mismatches, monitoring, 122–123
 - speeds, configuring, 118
 - states,
 - RSTP, 284
 - STP, 217–218
 - status, displaying, 438
 - UDLD, enabling, 272
 - verifying active STP protection features, 274
 - power supply redundancy, configuring Catalyst switches, 363–365
 - powered device detection (PoE), 402–404
 - predictable network model, 19–20
 - preparing for exam
 - multicast, 491
 - QoS in a switched network, 492
 - scenarios, 485
 - advanced STP, 489
 - EtherChannel, 487
 - router redundancy with HSRP and GLBP, 490
 - traditional STP, 488
 - trunking and DTP, 485
 - VLANs, trunking, and VTP, 486
 - securing access and managing traffic in a switched network, 492–493
 - preventing bridging loops, 209

preventing collisions, 11
 preventing routing loops with RSTP
 BPDUs, 285
 configuring, 290
 convergence, 287
 port behavior, 283–284
 port states, 284
 preventing routing loops with STP
 redundant link convergence, 252
 BackboneFast, 256–257
 PortFast, 253
 UplinkFast, 254–255
 Root Bridges
 configuring, 244–246
 placement, 239–242
 STP, 250–251
 tuning, 247
 primary VLANs, 461
 privileged EXEC mode (CatOS), 86
 process switching, 68
 promiscuous mode (switch ports), 461
 proposal messages (RSTP), switch synchronization, 287–288
 protecting against sudden BPDU loss, 270
 protocol data unit (PDU), 9
 pruning (VTP), 170–172
 punt adjacencies, 322
 PVID (Port VLAN ID), 136
 PVLANs (private VLANs), 460–461
 associating secondary VLANs to primary, 465
 configuring, 462–465
 PVST+ (Per-VLAN Spanning Tree Plus), 226–227, 292

Q

QoS, 410
 best effort, 412
 DiffServ, 412–413
 Layer 2 classification, 413
 Layer 3 classification, 414–416
 implementing on voice networks, 416–417
 IntServ, 412
 packet classification, 416–417
 trust configuring, 417–420
 verifying, 420–422

R

ranges, ports selection, 117
 recovering passwords, 88
 recovering from switch port error conditions, 121
 redundancy, 333
 Catalyst switches, 359–361
 non-stop forwarding, 363
 power supplies, 363–365
 supervisor synchronization, 362
 EtherChannel, 184
 gateway addresses, 337, 358
 GLBP, 350–357
 HSRP, 338–346
 VRRP, 347–348
 HSRP, 338
 link convergence (STP)
 BackboneFast, 256
 PortFast, 253
 UplinkFast, 254–255
 switches, 359–360
 regions (MST), 294
 defining, 297–298
 IST instances, 295
 MSTIs, 296
 relieving network congestion, 13
 remote access, 88–89
 removing descriptions from switch ports, 118
 request advertisements (VTP), 164
 reserved IP multicast addresses, 377
 restricting switch access
 accounting, 435–436
 authentication, enabling on Catalyst switches, 431–433
 authorization, 434–435
 revision numbers (VTP), setting to zero, 165
 roles, RSTP switch ports, 284–286
 rollover cables, 114
 Root Bridges
 configuring, 243–246
 election procedure, 211–212
 network diameter value, configuring, 220
 placement of, 239–242
 Root Bridge ID value, 211
 Root Guard, 267–268

Root Path Cost, 212
calculating, 213
tie conditions, 215
tuning, 247–248
root ports (RSTP), 286
on RSTP topologies, 284
RSTP, 286
election procedure, 212–214
root-inconsistent STP state, 268
route cache switching, 65, 315
router election (HSRP), 338–342
router on a stick, 311
router redundancy, HSRP, 338
routers, BSR, 386
routing, 256. See also interVLAN routing
 IP multicast
 IGMP, 379–380
 RPF, 378
 Layer 3, 11
 Multicast, 378
routing loops, 254
prev, 239–242
preventing with STP, 252
RP (Rendezvous Point), 383–385
RPF (Reverse Path Forwarding), 378
RPR (Route Processor Redundancy), 359–360
RPVS+ (Rapid PVST+), 283, 291–292
RSPAN
 co, 474–476
 configuring, 475–476
RSTP (Rapid Spanning Tree Protocol)
 BPDUs, 285
 configuring, 290
 convergence, 285–288
 edge ports, configuring, 290
 interoperability with STP, 285
 ports
 behavior, 283–284
 states, 284
 types, 286
 switch ports
 point-to-point links, configuring, 290
 role assignments, 284
 roles versus states, 284
 topology changes, 289
rules, 80/20, 18
running-config, copying files to startup config, 94

S

SAP, 14
SC connectors, 114
scaling
 core block, 39
 Layer 2 switching, 10
 VLANs, 139–140
scenarios, 485
 advanced STP, 489, 497
 EtherChannel, 487, 495
 multicast, 491, 499
 QoS in a switched network, 492, 499–500
 router redundancy with HSRP and GLBP, 490,
 498–499
securing access and managing traffic in a
 switched network, 492–493, 500–502
traditional STP, 488, 496
trunking and DTP, 485, 494
 VLANs, trunking, and VTP, 486, 494–495
secondary VLANs, 461, 465
security, CatOS passwords, 87–88
segmentation, 11
selecting
 Designated Ports, 215–217
 ranges of ports, 117
 Root Ports (STP), 212–214
 switch ports for configuration, 116
server farm block, 31, 39–40
server mode (VTP), 161, 166
Service Advertisement Protocol (SAP), 14
service provider edge block, 31, 41–42
SFP (small form factor pluggable) modules, 115
shared network models, 13–14
show adjacency summary command, 320
show cdp neighbors detail command, 45
show commands
 output, filtering, 95
 troubleshooting CatOS, 95
show etherchannel load-balance command, 194
show etherchannel port command, 192
show etherchannel port-channel command, 187
show etherchannel summary command, 192

show glbp command, 356
 show interface command, 121, 173
 show interface status command, 325
 show interface trunk command, 151–152
 show interfaces switchport command, 151
 show ip cef command, 317
 show ip interface brief command, 327
 show ip interface command, 326
 show lacp sys-id command, 194
 show mac address-table command, 74
 show port-security interface command, 438–439
 show power command, 365
 show spanning-tree interface command, 218, 249
 show spanning-tree vlan command, 252, 291
 show vlan command, 138, 325
 show vlan id command, 150
 show vtp commands, 173
 show vtp counters command, 169
 show vtp status command, 165, 169
 shutdown command, 121, 325
 silent submode (PAgP), 190
 single-tagging, 144
 sizing switch block, 33–35
 source, 143
 SPAN (Switched Port Analyzer), 470
 deleting sessions, 472
 local SPAN, 470–474
 RSPAN, 474–476
 VSPAN, 471–474
 spanning-tree guard loop command, 271
 spanning-tree guard root command, 268
 spanning-tree portfast command, 290
 Spanning-Tree Protocol, 33
 Sparse Mode (PIM), 382–384
 Sparse-Dense Mode (PIM), 384
 speed command, 119
 spoofing attacks, mitigating
 ARP inspection, 443–446
 DCHP snooping, 441–443
 Spurgeon, Charles, 108
 SSO (Stateful Switchover), 360
 stale entries (CAM tables), 69
 startup configuration, 87, 94
 static CAM table entries, configuring, 69
 static VLANs
 configuring, 137–138
 port-based membership, 136
 store-and-forward switching, 61
 STP (Spanning Tree Protocol). See also MST; RSTP
 active protection features, verifying on switch ports, 274
 Blocking state, 217
 BPDU Guard, 268–269
 BPDUs
 Configuration BPDUs, 209–210
 protecting against sudden loss, 270
 TCN BPDUs, 220
 bridging loops, 207–208
 broadcast storms, 208
 preventing, 209
 CST, 226
 Designated Ports
 election procedure, 215–216
 selecting, 216–217
 disabled state, 217
 disabling with BPDU filtering, 274
 displaying information, 257
 forwarding state, 217
 interoperability with RSTP, 285
 learning state, 217
 listening state, 217
 loop guard, 270–271
 MST
 IST instances, 295
 MST instances, 296
 network diameter value, configuring, 220
 Path Cost, 213
 Port ID, tuning, 248–249
 PVST, 226
 PVST+, 227
 redundant link convergence, 252
 BackboneFast, 256–257
 PortFast, 253
 UplinkFast, 254–255
 Root Bridge
 configuring, 243–246
 election procedure, 211–212
 placement, 239–242
 Root Guard, 267–268
 Root Path Cost, tuning, 247–248

- Root Ports
 - election procedure, 212–214
 - Root Path Cost, 212
 - running multiple instances of, 293
 - switch ports, roles versus states, 284
 - timers, 219
 - automatic configuration, 251–252
 - manual configuration, 250–251
 - modifying, 250–251
 - topology changes
 - direct, 221–222
 - indirect, 222, 224
 - insignificant, 224–225
 - troubleshooting, 257, 274
 - UDLD, 271–273
 - unknown unicast frames, 206
 - subset advertisements, 164
 - summary advertisements, 163
 - superior BPDUs, 268
 - supervisor modules, redundant switch supervisors, 359–360
 - supervisor synchronization, Catalyst switches, 362
 - SVIs (switched virtual interfaces), 312–314, 465
 - switch block, 31–33
 - connections
 - console port, 114
 - Ethernet port cables, 114–115
 - Gigabit Ethernet port cables, 115–116
 - distribution layer, 33
 - sizing, 33–35
 - switch chassis, 359–360
 - switch ports
 - aggregation, EtherChannel, 183
 - assigning to VLANs, 138
 - BPDUs filtering, enabling, 274
 - configuring, 116
 - connectivity troubleshooting, 122–123
 - duplex mode configuring, 119
 - errdisable state, 269
 - error conditions
 - detecting, 119–120
 - recovering from, 121
 - identifying, 118
 - loop-inconsistent state, 270
 - PortFast configuring, 253–254
- roles
 - assignments, 284
 - assigned in Root Guard, 267
 - versus states (RSTP), 284
- RSTP, roles, 286
 - selecting for configuration, 116
- SPAN, 470–474
 - RSPAN, 474–476
 - VSPAN, 471–474
- speed
 - configuring, 118
 - displaying, 121
- text descriptions, adding, 118
- trunks
 - configuring, 146–147
 - example configuration, 148–149
- UDLD enabling, 272
- verifying active STP protection features, 274
- VLANs
 - and multiple subnets, 141
 - tagging, 143–144
 - troubleshooting, 150–152
 - trunk links, 141
- switches
 - CatOS, passwords, 87–88
 - CDP, viewing information, 96–97
 - console ports, connecting to, 114
 - Fast Ethernet ports, 114
 - file management, 90
 - configuration files, 91–92
 - image files, 90–91
 - moving files, 92–94
 - host names, changing, 86
 - inter-switch communication, 89
 - operating systems, 85–86
 - port security, 436–439
 - remote access, 88–89
 - spoofing, 466–467
 - VLANs, deleting, 138
 - VTP
 - configuring, 165–167
 - example configuration, 169
 - switching
 - CAM, 69–70, 74–75
 - frame processing, 63–65
 - functionality, 9–12
 - Layer 2, 10

Layer 3, 11
 Layer 4, 12
 MLS (multilayer switching), 12, 65–68
 multicast
 traffic, 386–388
 verifying, 389
 store-and-forward, 61
 TCAM tables, 70
 example, 72
 port operations, 73
 structure, 70–71
 troubleshooting, 75
 VMR combinations, 71
 transparent bridging, 61–63
 trunks, VTP, 161–164
 switchport command, 138, 146, 312–313
 synchronization
 VTP problem, 163
 RSTP switches, 287–288
 syntax, CAM table commands, 69
 system priority value, 188
 system_env_vars.txt file, 92

T

tagging, 143
 IEEE 802.1Q, 144
 ISL, 143–144
 TC (topology change) messages, 289
 TCAM (Ternary Content Addressable Memory), 64, 459
 tables, 70
 example of, 72
 port operations, 73
 structure of, 70–71
 VMR combinations, 71
 TCI (Tag Control Information) field, 145
 TCN BPDU, 220
 Telnet, remote access, 88–89
 text descriptions, adding to switch ports, 118
 throttling adjacencies, 321
 thwarting VLAN hopping, 469
 tie conditions of Root Path Cost, 215
 timers (STP), 219
 automatic configuration, 251–252

manual configuration, 250–251
 modifying, 250–251
 Token Ring
 collisions, susceptibility to, 13
 support on VTP version 2, 168
 topologies
 changes
 direct, 221–222
 indirect, 222–224
 insignificant, 224–225
 RSTP, detecting, 289
 flat network, 135
 topology-based MLS, 65
 ToS (type of service), 414
 traffic
 core block, 36–38
 flooding, VTP pruning, 172
 multicast, 14
 patterns, 20/80 rule, 140
 transparent bridges, 61–63
 redundancy, 207
 versus Ethernet switches, 205–206
 transparent mode (VTP), 162
 configuring, 167
 version-dependent, 168
 troubleshooting
 CAM table operation, 74–75
 CatOS
 debug commands, 96
 show commands, 95
 EtherChannel, 191–194
 STP, 257, 274
 switch ports
 connectivity, 122–123
 error conditions, 119–121
 TCAM table operation, 75
 trunks, 150–152
 VLANs, 150–152
 VTP, 173
 trunk links, 141–144
 trunking
 DTP, disabling, 148
 IEEE 802.1Q, CST, 226
 status, displaying, 148
 VTP, 157, 161, 169
 advertisements, 161–164
 client mode, 162

client mode, configuring, 167
 configuring, 165
 configuring management domains, 166
 configuring transparent mode, 167
 configuring version, 167–168
 example configuration, 169
 management domains, 161, 166
 pruning, 170–172
 server mode, 161
 server mode, configuring, 166
 subset advertisements, 164
 summary advertisements, 163
 transparent mode, 162, 167
 troubleshooting, 173

trunks, 141–142
 accessing with switch spoofing, 466–467
 configuring, 146–147
 DTP, 145–146
 example configuration, 148–149
 troubleshooting, 150–152
 VLAN hopping, 468–469
 trust boundaries, 417–420

U

UDLD (Unidirectional Link Detection), 271–273
 enabling, 272
 message interval, configuring, 272
 modes of operation, 272

udld command, 272
 unicast traffic, 375
 unidirectional links, 271
 unknown unicasts
 flooding, 63
 frames, 170, 206
 unrecognized TLV (Type-Length-Value) support,
 VTP version 2, 168

uplink ports, BPDU guard, enabling, 269
 UpLinkFast, 254–255
 enabling, 255
 status, displaying, 255

user EXEC mode, login passwords configuring, 87
 User EXEC mode (CatOS), 86

V

VACLs
 configuring, 459–460
 matching conditions, defining, 459–460
 verifying
 active STP features on switch ports, 274
 CEF, 327–328
 effectiveness of EtherChannel load-balancing, 187
 fallback bridging, 328
 gateway redundancy, 358
 GLBP operation, 356
 inline power for Cisco IP Phones, 405
 MLS, interVLAN routing, 324–327
 multicast routing, 388
 multicast switching, 389
 PoE power status, 405
 QoS, 420
 VLAN configuration, 138
 voice QoS operation, 420–422
 voice VLAN operation, 409

version-dependent transparent mode, 168
 VID (VLAN Identifier), 145
 viewing
 CAM table entries, 74
 CDP information, 96–97
 ports in errdisable state, 438
 STP information, 257
 switch ports, 121, 268
 trunking status, 148
 VTP status, 169

vlan.dat configuration file, 92
 VLANs, 15, 135, 460–461. See also VACLs
 deleting, 138
 deploying, 139
 dynamic VLANs, 139
 end-to-end deploying, 140
 extended-range, 137
 hopping, 468–469
 IEEE 802.1Q, CST, 226
 interVLAN routing, 311
 configuring, 312–314
 interface types, 312
 Layer 2 ports, configuring, 312
 Layer 3 ports, configuring, 313–314
 SVI ports, configuring, 314
 verifying, 324–327

- IP addressing scheme, 139
 - local deployment, 140
 - management VLAN
 - IP address, 88
 - IP address assignment, 89
 - mapping to multiple STP instances, 294–295
 - IST, 295
 - MSTIs, 296–297
 - membership methods, port-based, 136
 - MST
 - IST instances, 295
 - MST instances, 296
 - PVLANs, configuring, 462–465
 - PVST, 226
 - secondary, associating to primary VLAN SVI, 465
 - SPAN, 470
 - deleting sessions, 472
 - local SPAN, 470–474
 - RSPAN, 474–476
 - VSPAN, 471–474
 - static VLANs, configuring, 137–138
 - tagging, 143
 - IEEE 802.1Q, 144
 - ISL, 143–144
 - troubleshooting, 150–152
 - trunks, 141–142
 - configuring, 146–147
 - DTP, 145–146
 - example configuration, 148–149
 - links, 141
 - VTP, 157, 161–169
 - verifying configuration, 138
 - voice VLANs, 406
 - configuring, 407–409
 - verifying operation, 409
 - VTP
 - pruning, 170–172
 - troubleshooting, 173
 - version 2, consistency checks, 168
 - VMR (Value, Mask, and Result) combinations, 71
 - voice
 - networks, QoS implementing, 416–417
 - QoS operation, verifying, 420–422
 - VLANs, 406
 - configuring, 407–409
 - verifying operation, 409
-
- VoIP**
 - Cisco IP Phones
 - inline power, 403
 - PoE, 401–405
 - QoS, 410
 - trust, configuring, 418–420
 - verifying, 420
 - voice VLANs, 406
 - configuring, 407–409
 - verifying operation, 409
 - VRRP (Virtual Router Redundancy Protocol), 347–348
 - VSPAN, 471–474
 - VTP, 157, 161
 - advertisements, 161–163
 - requests, 164
 - subset advertisements, 164
 - summary advertisements, 163
 - client mode, 162, 167
 - configuring, 165
 - example configuration, 169
 - extended-range VLAN membership, 137
 - management domains, 161, 166
 - configuring, 166
 - parameters, displaying, 169–170
 - viewing status, 169
 - pruning, 170–172
 - revision number, setting to zero, 165
 - server mode, 161, 166
 - transparent, 162, 167
 - troubleshooting, 173
 - version configuring, 167–168
 - version 2 consistency checks, 168
 - version-dependent transparent mode, 168
 - vtp mode transparent command, 137
 - VTP synchronization problem, 163

W

- WAN PHY, 113
- wave, 288
- workgroups, 18
- WWDM (wide-wavelength division multiplexing), 113

X-Y-Z

XDI. See CatOS
XOR (exclusive-OR) operation, 184