

# Index

## *Numerics*

- 1Gbit (Gigabit) Fibre Channels, 66
- 2-Gbit Fibre Channel SAN networks, 244
- 4-Gbit Fibre Channel SAN networks, 244
- 4-Gbit Fibre Channels, 66
- 8-port modular-class switches, 35
- 9µm cables, 40–42, 82–83, 216, 311
- 10Base-T networks, 244
- 16-port modular-class switches, 35, 106
- 24-port modular switches, 106
- 32-port modular switches, 106
- 50µm multimode (MM) cables, 40, 42, 82–83
- 62.5µm SM cables, 41–42, 82–83
- 100Base-T networks, 244
- 1000Base-T networks, 244

## • A •

- abstraction, 379–380
- adaptive RAID, 53
- addraidgroup parameter,
  - arraycfg command, 174
- addressing, fabric
  - name server, 73–74
  - overview, 72
  - WWNs, 72–73
- addressing, loop, 69
- administrative layers, datacenter, 381
- Advanced Encryption Standard (AES), 338
- agent-based management, 288
- agents, 223, 288
- AIT tape drives, 229
- Alacritech, 204
- Alcatel-Lucent, 203
- AliasCreate command, 182
- aliases, zone, 137, 160
- appliance-based data replication, 152–154
- appliance-based de-duplication, 339
- appliance-based write splitting, 361–362
- application servers, 13
- applications
  - availability of, 408
  - backup, 22
  - cluster, 22
  - consistency groups, 364–365
  - critical, 144
  - for data de-duplication, 354–356
  - database, 151
  - dependencies, 142
  - development of, 11
  - disaster recovery, 364
  - interoperability of, 364
  - performance of, 412
  - quiescing, 265–266
  - for SANs, 21–22
  - server-class computer, 21
  - testing of, 11
- arbitrated loop topology
  - cascading hubs, 99–100
  - creating resilient hub networks, 102–103
  - fault-tolerant loops, 104–105
  - loop of hubs, 101
  - overview, 98–99
- arbitrated loops, 68–69
- architects, SAN, 299–300
- archiving, data, 225–226, 355
- array-based data replication, 154–155, 375
- array-based write splitting, 362
- arraycfg command, 172–175
- arrays
  - connectivity, 177–178
  - of drives, 48
  - hardware configuration, 172–174
  - overview, 172
  - RAID setup, 174–177
- Asigra, 377
- asset tag numbers, 282–283
- asynchronous data transmission, 147–148
- asynchronous remote copy solutions, 148
- Atempo, 377
- atomicity, 358
- automation, SAN
  - backups, 295
  - managing database storage, 296
  - overview, 294–295
- availability, 49

• **B** •

- backup applications, SAN, 22
- backup process, 225. *See also* backups
- backup servers, 13, 22
- backup windows, 11, 225, 227–228, 358
- backups
  - automation, 295
  - backup window, 227–228
  - congestion, 80
  - data replication, 242
  - de-duplication in, 354–355
  - differential, 344
  - disk-to-disk, 237–239
  - image copies, 240
  - incremental, 141, 344
  - LAN-less, to shared tape library over SAN, 235–236
  - media requirements for, 353
  - migration, 192
  - of multiple remote offices, 417–418
  - over corporate LAN to tape drive, 233–234
  - over corporate network to robotic tape library, 234
  - overview, 225–227, 230–232
  - policies, 230
  - recovering databases with, 369
  - remote, 242
  - serverless, to shared tape library, 236–237
  - snapshot copies, 241
  - speed of, 242–246
  - on tape, 199
  - tape drives, 228–229, 232–233
  - tape libraries, 229
  - use of hubs for, 32–33
  - using CDP to eliminate, 372–374
- BakBone, 377
- bandwidth
  - design, 77–78
  - importance of, 145–147
  - of IP Network link types, 206
  - overview, 66
  - requirements for disaster recovery, 142
  - of switches, 108
- Basic Input Output System (BIOS), 24, 26–27
- BCP (business continuity plan), 139
- BCVs (business continuance volumes), 232, 250, 251, 374
- bends, in fiber-optic cable, 83
- best practices
  - director-class switch, 136
  - overview, 135
  - standardizing firmware versions, 136
  - standardizing HBA drivers, 137
  - standardizing on single vendor's switches, 136
  - storage from multiple vendors, 137
  - for storage in CDP solutions, 367–368
  - unique zone alias names, 137
  - using two fabrics, 138
- Big Iron hardware, 387–388
- BIOS (Basic Input Output System), 24, 26–27
- bitmap tables, 262–263
- bits, 66
- blade servers, 386
- blades, 36, 107, 362
- block-based disk drives, 9
- block-level delta versioning, 344
- block-level hashing, 341, 347–348
- Bluefin, 285
- bridges, 16, 38
- Brocade FCIP solutions, 203
- Brocade HBAs, 86
- Brocade iFCP-based SAN extenders, 215
- Brocade switches
  - commands, 129–130
  - enabling with new ID, 134–135
  - naming, 132
  - overview, 131–132
  - setting domain ID, 132–133
  - vendor information, 89
- budget, disaster-recovery, 143
- buffer credits, 213, 215
- building SANs
  - array configuration, 172–177
  - connectivity, 177–180
  - data migration, 191–192
  - documentation, 275–276
  - iSCSI protocol, 188–191
  - manual set up, 158–159
  - overview, 275
  - SAN plan, 159–161
  - servers, preparing, 170–172
  - setting up, 162–170
  - starting small, 275
  - Unix servers, 184–187
  - Windows servers, 187–188
  - zones, configuring, 180–183
- bulk data movement, 11
- bus architecture arrays, 59
- business continuance volumes (BCVs), 232, 250, 251, 374
- business continuity plan (BCP), 139
- bytes, 66, 77

## • C •

- cable labeling
  - data center coordinate system, 280–282
  - documenting cable arrangements, 283
  - overview, 85, 279–280
  - standard naming convention, 282–283
- cable management
  - logical, 279
  - overview, 276–277
  - physical, 277–278
- cable-connector types, 43
- cables
  - avoiding connection issues, 83
  - copper, 64–65
  - documentation of arrangements, 283
  - failure in physical loop topologies, 102–103
  - fiber-optic, 159
  - Fibre Channel, 28
  - host bus adapters, 85–86
  - host layer components, 26
  - issues with, 76
  - macro-bends, 83–85
  - maps of, 283
  - micro-bends, 83–85
  - mixing switch vendors, 89–90
  - numbering, 281–282
  - overview, 40–42, 82–83
  - patch panels, 83–85
  - single vendor, 86–88
  - troubleshooting, 311–312
- cache hits, 320
- cache memory, 16, 57–61, 412
- cascading hubs, 32, 99–100
- catastrophic problems, 310, 322
- CDP (Continuous Data Protection)
  - backups, eliminating, 372–374
  - best practices for storage, 367–368
  - cost reduction, 374–376
  - data protection solutions, 368–371
  - database-like storage, 358–366
  - overview, 232, 357–358
  - recovery, simplifying, 374–376
  - versus snapshots, 371–372
  - vendors, 376–377
- CDR (Continuous Data Replication), 375
- cells, SAN, 111
- certification matrices, 86
- change management, 291
- chunks, data, 342–343, 348
- Ciena, 203
- CIFS (Common Internet File Services)
  - protocol, 220–221, 413
- CIM (Common Information Model), 285
- cipher blocks, 338
- Cisco SAN extenders, 203–204
- Cisco switches, 89, 131
- Citrix, 387
- cladding, 42, 65, 83
- classification, storage arrays, 55–56
- CLI (command-line interface), 259
- cluster applications, 22
- co-location facilities, 150
- command devices, 290
- command-line interface (CLI), 259
- commands
  - switch, 129–130, 132–135, 165, 312
  - zone, 181–183
- committed transactions, 359
- Common Information Model (CIM), 285
- Common Internet File Services (CIFS)
  - protocol, 220–221, 413
- communication, SAN device, 18–20
- communication sessions, 215
- CommVault, 377
- companies, SAN equipment, 20
- complete copies, 254–256
- complete data PiT copies, 256
- complex SLAs, 297
- components, logical paths through, 308
- compression, 208–209, 245
- compression ratio, 245
- compute layer, 383
- config files, 309
- ConfigAdd command, 183
- ConfigCreate command, 170
- ConfigEnable command, 170, 182–183
- configUpload command, 134–135
- configuration files, HBA, 317
- configure command, 132–133
- configuring
  - array, 172–177
  - switches, 164–166
  - zones, 180–183
- congestion, 80
- connections
  - issues, 83
  - multiple, 10
  - types of, 205–208
- connectivity, 25, 177–180
- consistency groups, 142, 363–365
- consistent state, 266
- consolidation, 197
- continuous backups, 232

- Continuous Data Protection (CDP)
  - backups, eliminating, 372–374
  - best practices for storage, 367–368
  - cost reduction, 374–376
  - data protection solutions, 368–371
  - database-like storage, 358–366
  - overview, 232, 357–358
  - recovery, simplifying, 374–376
  - versus snapshots, 371–372
  - vendors, 376–377
- Continuous Data Replication (CDR), 375
- continuous problems
  - overview, 310, 318
  - performance bottlenecks, 319–321
  - wrong LUN security, 318–319
  - zoning changes, 318
- controllers, 16, 173, 177
- coordinate system, data center
  - marking coordinates on grid, 280–281
  - numbering cables, 281–282
  - overview, 280
- copper cables, 40, 64–65
- copy on write technology, 241
- copying speeds, 207–208
- copying to SAN disks, 192
- core fabric switches, 37
- core-edge SAN design, 37
- core-edge topology, 119–122
- cores, fiber-optic cable, 41–42, 65, 78, 79, 82
- corporate networks, 231, 234
- corruption-recovery images, 250–251
- costs
  - CDP reduction of, 374–376
  - compression, 208–209
  - de-duplication, 210
  - of downtime, 140
  - of hubs, 33
  - link speed, 146
  - management of, 11
  - reduction of, with SAN, 410, 414–415
  - of replication, 144
  - of SANs, 415–416
  - of switches, 136
  - WAN tuners, 211
- critical applications, 144
- critical data, 11
- critical records analysis, 364
- D •
  - dark fiber cables, 40
  - DAS (direct attached storage), 96–97, 407
  - DAT tape drives, 229
  - data
    - archiving, 225–226, 355
    - asynchronous transmission, 147–148
    - bulk movement of, 11
    - client access to in disasters, 144
    - copying, 198–199
    - critical, 11
    - encryption standards, 338
    - latency, 79–80
    - retention, 355
    - security, 71
    - sharing, 198–199
    - synchronous transmission, 147
    - transfer speeds, 29
  - data cache, 346
  - data center coordinate system
    - marking coordinates on grid, 280–281
    - numbering cables, 281–282
    - overview, 280
  - data de-duplication
    - applications for, 354–356
    - block-level hashing, 341, 347–348
    - cost reduction with, 210
    - in datacenter, 338–339
    - delta versioning, 343–346
    - example, 356
    - file-based compare and compression, 340
    - file-level hashing, 340–341, 347
    - hash collisions, 350–352
    - importance of, 352–353
    - in-band versus out-of-band, 346–347
    - overview, 335–339
    - sub-block-level hashing, 341–343, 348–350
    - using in SAN, 347–352
    - vendors, 339
    - with virtual tape, 397
  - data domains, 190
  - Data Encryption Standard (DES), 338
  - data journaling, CDP, 359–360, 365–366
  - data migration
    - backup/restore, 192
    - disk-to-SAN, 192
    - network, 192
    - overview, 191

- data protection solutions
  - near CDP, 370
  - overview, 368
  - snapshots, 370
  - traditional backups, 369
  - true CDP, 370–371
- data replication
  - appliance-based, 152–154
  - array-based, 154–155
  - de-duplication in, 355
  - formula for, 147
  - host-based, 151–152
  - methods for, 143–144
  - overview, 151, 242
  - recovery speed with, 199
  - shipping tapes, 155–156
  - with virtual tape, 397
  - without SANs, 418
- data routers, 38–39, 47
- database application servers, 21, 81
- database applications, 151
- database recovery
  - near CDP, 370
  - overview, 368
  - snapshots, 370
  - traditional backups, 369
  - true CDP, 370–371
- database servers, 12
- database storage management, 296
- database-like storage, CDP
  - consistency groups, 363–365
  - data journaling, 359–360
  - overview, 358–359
  - sizing journals, 365–366
  - write splitting, 360–362
- datacenters, 9–10, 338–339
- data-flushing backup mode, 266
- DC (domain-class) solutions, 387
- decibels (dBs), 79
- dedicated backup servers, 227–228, 231
- dedicated parity drives, 52
- de-duplication, data
  - applications for, 354–356
  - block-level hashing, 341, 347–348
  - cost reduction with, 210
  - in datacenter, 338–339
  - delta versioning, 343–346
  - example, 356
  - file-based compare and compression, 340
  - file-level hashing, 340–341, 347
  - hash collisions, 350–352
  - importance of, 352–353
  - in-band versus out-of-band, 346–347
  - overview, 335–339
  - sub-block-level hashing, 341–343, 348–350
  - using in SAN, 347–352
  - vendors, 339
  - with virtual tape, 397
- deferred disk procurement, 10
- Dell, 204, 387
- delta versioning, 343–347
- deltas, 344
- Dense Wave Division Multiplexing (DWDM), 202–203, 216, 218
- DES (Data Encryption Standard), 338
- design, backup
  - corporate LAN to tape drives, 233–234
  - corporate network to robotic tape library, 234
  - data replication, 242
  - disk-to-disk, 237–239
  - image copies, 240
  - LAN-less backup to shared tape library over SAN, 235–236
  - overview, 230–232
  - remote backup, 242
  - serverless backup to shared tape library, 236–237
  - snapshot copies, 241
  - tape drives in servers, 232–233
- design, SAN
  - arbitrated loop topology, 98–105
  - bandwidth, 77–78
  - best practices, 135–138
  - congestion, 80
  - distance between components, 78–79
  - excess latency, 79–80
  - fabric topologies, 110–122
  - initial switch setup, 130–135
  - issues with, 76
  - over-subscription, 81–82
  - overview, 93–96
  - point-to-point topology, 96–98
  - switched fabric topology, 105–110
  - zoning, 123–130
- diagnostic software, storage array, 315
- diagrams, SAN, 158
- Dial Home function, 314
- dial-up connections, 205
- differential backups, 230, 344, 418
- digital subscriber line (DSL), 205
- direct attached storage (DAS), 96–97, 407
- direct mapping, 391–393

- director-class switches,
    - 36–37, 105–106, 121–122, 135–136
  - disaster-recovery (DR)
    - bandwidth, 145–147
    - block-level delta versioning, 344
    - CDP, 374–376
    - data replication, 151–156, 418
    - de-duplication, 355
    - distance, 145
    - downtime, 140–144
    - latency, 147–148
    - multiple applications, 408
    - overview, 10
    - plans, 139
    - recovery sites, 148–150
    - single applications, 415
    - testing, 156
  - disk arrays, 10
  - disk drives, 9, 25–26, 172, 174, 226
  - disk mirroring, 51
  - disk partitions, 53–55
  - disk sharing, 198–199
  - disk storage, 268–269
  - disk striping, 50, 52
  - disk utilization, 10, 407–408
  - disk-to-disk backups, 231, 237–239
  - disk-to-SAN migration, 192
  - distance
    - between components, 78–79
    - effect on data latency, 80
    - limits on, 10
    - between production and recovery data centers, 142
    - to recovery sites, 145
  - DLT tape drives, 229
  - documentation
    - cable arrangements, 283
    - disaster-recovery plans, 156
    - SAN component, 275–276
    - SAN setup, 162
    - for troubleshooting, 307
  - domain IDs, 130, 132–135, 161, 163–164, 219
  - domain names, 128
  - domain servers, 386
  - domain-class (DC) solutions, 387
  - downtime
    - gathering data for plan, 141–143
    - overview, 140–141
    - plan requirements, 143–144
    - using two HBAs, 112
  - DR (disaster-recovery)
    - bandwidth, 145–147
    - block-level delta versioning, 344
    - CDP, 374–376
    - data replication, 151–156, 418
    - de-duplication, 355
    - distance, 145
    - downtime, 140–144
    - latency, 147–148
    - multiple applications, 408
    - overview, 10
    - plans, 139
    - recovery sites, 148–150
    - single applications, 415
    - testing, 156
  - drivers
    - filter, 87, 112, 385
    - issues with, 76
    - loading, 171
    - support for, 20
  - drives, tape, 226, 228–229, 231–234, 236, 245–246
  - DSL (digital subscriber line), 205
  - Dual meshed fabric topology, 116
  - dual switches
    - overview, 110
    - using path-management software, 112–113
    - using two HBAs, 112
  - dumb terminals, 417
  - DWDM (Dense Wave Division Multiplexing), 202–203, 216, 218
- **E** ●
- E\_Port, 44, 46, 167
  - E-Copy, 236–237
  - EFC Manager software, 135
  - Egenera, 387
  - 8-port modular-class switches, 35
  - election process, 217–219
  - electrical outages, 149
  - EMC, 204, 320, 377
  - Emulex, 86–87
  - encapsulated messages, 19
  - encryption standards, 338
  - endpoint mapping, cable, 280
  - engineers, SAN, 300
  - enterprise arrays, 17
  - Enterprise Storage Connection (ESCON)
    - cables, 82–83
  - Enterprise Virtual Array (EVA), 384, 402
  - enterprise-class arrays, 17–18, 56–57, 60
  - enterprise-class switches, 36–37
  - entrances, disaster recovery facility, 149
  - E-ports, 89

ESCON (Enterprise Storage Connection)  
 cables, 82–83  
 Ethernet LAN ports, 188, 191  
 EVA (Enterprise Virtual Array), 384, 402  
 events, records of, 291  
 excess latency  
   distance, 80  
   hops, 79  
   overview, 79  
 extended copies, 237  
 Extended Ports, 167  
 extenders, SAN, 202–205  
 extent pool mapping, 391, 394  
 extents, 394  
 external storage, 97

● **F** ●

F\_Port, 44–45  
 fabric addressing  
   name server, 73–74  
   overview, 72  
   WWNs, 72–73  
 fabric IDs, 29  
 fabric layer  
   cable-connector types, 43  
   cables, 40–42  
   components of, 15–16  
   data routers, 38–39  
   hubs, 30–33  
   overview, 29, 94  
   ports, 43–46  
   protocols used in Fibre Channel  
     SAN, 46–48  
   storage fabrics, 29–30  
   switches, 33–37  
   using two, 137  
   virtualization, 383  
 fabric ports, 44  
 fabric switches, 159, 163, 312–313  
 fabric topologies  
   core-edge, 119–122  
   defined, 95  
   dual switches, 110–113  
   loop-of-switches, 113–114  
   meshed fabric, 114–117  
   overview, 110  
   star, 117–119  
 fabric-based storage virtualization, 390–391  
 fabric-based storage virtualization  
   vendors, 402

  fabric-based write splitting, 361  
 fabric-level replication appliances, 152  
 fabrics, switched  
   choosing switches, 107–108  
   fabric addressing, 72–74  
   fabric protocol, 71–72  
   FC-SW protocol, 46  
   overview, 29–30, 70–71, 95, 105–106  
   trunking, 108–110  
   types of SAN switches, 106–107  
   using right bandwidth, 108  
   zoning, 123  
 fabric-to-loop ports, 44  
 facilities, disaster recovery, 149–150  
 fail-over filter drivers, 112  
 FalconStor, 204, 377, 384  
 fan-in ratio, 80–82  
 fault-tolerant loops, 104–105  
 FC (Fibre Channel) cables, 65  
 FC (Fibre Channel) disk drives, 25–26  
 FC (Fibre Channel) extenders, 211  
 FC (Fibre Channel) loops, 30–32, 100  
 FC (Fibre Channel) ports, 97  
 FC (Fibre Channel) protocol  
   arbitrated loop, 68–69  
   loop addressing, 69  
   overview, 8–9, 18–20, 67–68  
   role in SANs, 60  
   types of, 46–48  
 FC-AL (Fibre Channel-Arbitrated Loop)  
   protocol, 18, 31, 46, 68–69  
 FCIP (Fibre Channel over Internet Protocol),  
   211–213  
 FCIP (Fibre Channel over Internet Protocol)-  
   based extenders, 202–203, 216  
 FC-SW (Fibre Channel-Switched) protocol,  
   18, 46  
 feed speed, 242  
 fiber-optic cables, 15, 64–65, 159  
 Fibre Channel (FC) cables, 65  
 Fibre Channel (FC) disk drives, 25–26  
 Fibre Channel (FC) extenders, 211  
 Fibre Channel (FC) loops, 30–32, 100  
 Fibre Channel (FC) ports, 97  
 Fibre Channel (FC) protocol  
   arbitrated loop, 68–69  
   loop addressing, 69  
   overview, 8–9, 18–20, 67–68  
   role in SANs, 60  
   types of, 46–48

- Fibre Channel over Internet Protocol (FCIP), 211–213
- Fibre Channel over Internet Protocol (FCIP)-based extenders, 202–203, 216
- Fibre Channel-Arbitrated Loop (FC-AL) protocol, 18, 31, 46, 68–69
- Fibre Channel-Switched (FC-SW) protocol, 18, 46
- fibres, 8–9
- 50µm multimode (MM) cables, 40, 42, 82–83
- file servers, 12, 81, 413–414
- file shares, 413
- File Transfer Protocol (FTP), 192, 312–313
- file-based comparison, 340
- file-compression solutions, 340
- file-level hashing, 340–341, 347
- filter drivers, 87, 112, 385
- firmware
  - image copies, 240
  - monolithic arrays, 57
  - overview, 16, 25–27
  - standardizing, 136
- FL\_Port, 44–45
- flashlights, 311
- format command, 187
- formula, journal size, 366
- formulas, backup speed, 245–246
- 4-Gbit Fibre Channel SAN networks, 244
- 4Gbit Fibre Channels, 66
- framework, SAN management
  - compared to step-by-step administration, 293–294
  - intercommunication, 284–285
  - overview, 283
  - software, 284
  - use of, 286
- FTP (File Transfer Protocol), 192, 312–313
- full backup policies, 230
- full-duplex data transmission, 28

## ● G ●

- G\_Port, 44, 46
- gatekeepers, 290
- gateway approach, 213–215
- gateways, 16, 38, 211
- GBIC (Gigabit Interface Converter), 15, 24–29, 43, 60, 216
- Gbits (gigabits), 29, 77
- Gbps (gigabits per second), 29

- Gigabit (1Gbit) Fibre Channels, 66
- Gigabit Ethernet, 416
- Gigabit Interface Converter (GBIC), 15, 24–29, 43, 60, 216
- Gigabit Link Module (GLM), 24, 27–29
- gigabits (Gbits), 29, 77
- gigabits per second (Gbps), 29
- GLM (Gigabit Link Module), 24, 27–29
- global memory cache, 17
- global ports, 44
- golden configuration, 309–310
- graphic user interface (GUI), 259
- GRID computing networks, 19
- grids, coordinate system, 280–281
- GUI (graphic user interface), 259

## ● H ●

- handshakes, 18
- hard zoning, 127–128, 161
- hardware, 142, 172–174
- hardware-based PiT copies, 257–258, 269
- hardware-based server virtualization, 387–388
- hash collisions, 350–352
- hashing
  - block-level, 341
  - file-level, 340–341
  - overview, 337
  - sub-block-level, 341–343
- HBA (Host Bus Adapter)
  - backups, 244
  - choosing, 85–86
  - components of SANs, 159
  - configuration, 171
  - drivers, 20, 112, 137, 317–318
  - overview, 60
  - planning connections, 171–172
  - role in host layer, 15, 26–27, 93
  - role in SAN, 24
  - setting up, 170
  - troubleshooting, 314, 316–317
  - vendor testing of, 316
- HCA (Host Channel Adapters), 86
- HDS, 204, 384
- health monitoring
  - in-band management, 289–290
  - levels of monitoring, 289
  - out-of-band management, 289–290
  - overview, 287, 289

- heterogeneous SAN environments, 39
  - Hewlett-Packard, 387
  - high-level protocols, 67
  - Hitachi Universal Storage Platform (USP), 393, 402–403
  - hops, 25, 79, 113–115
  - Host Bus Adapter (HBA)
    - backups, 244
    - choosing, 85–86
    - components of SANs, 159
    - configuration, 171
    - drivers, 20, 112, 137, 317–318
    - overview, 60
    - planning connections, 171–172
    - role in host layer, 15, 26–27, 93
    - role in SAN, 24
    - setting up, 170
    - troubleshooting, 314, 316–317
    - vendor testing of, 316
  - Host Channel Adapters (HCAs), 86
  - host isolation, 258
  - host layer
    - fiber-optic cables, 15
    - Gigabit Interface Connector, 15
    - Gigabit Interface Converter, 27–29
    - Gigabit Link Module, 27–29
    - host bus adapters, 15, 26–27
    - overview, 14, 26, 93–94
  - host-based data replication, 151–152
  - host-based de-duplication, 339
  - host-based PiT copies, 257
  - host-based storage virtualization, 390–391
  - host-based storage virtualization vendors, 401–402
  - host-based write splitting, 361
  - hot backup mode, 232, 371
  - HP, 204, 377, 384
  - HP Enterprise Virtual Array (EVA), 402
  - hub ports, 15
  - hub-based networks, 59
  - hubs, 15, 30–33, 60, 98–99
- 1 •**
- IBM, 204, 384, 387
  - IEEE (Institute of Electrical and Electronics Engineers) addresses, 72
  - iFCP (Internet Fibre Channel Protocol), 211, 213–215, 219–220, 221
  - iFCP (Internet Fibre Channel Protocol)-based extenders, 203
  - ILM (Information Lifecycle Management), 395–396
  - image copies, 231–232, 240, 254
  - in-band de-duplication, 346–347
  - in-band management, 289–290
  - in-band virtualization, 399–400
  - in-band write splits, 360–361
  - incremental backups, 141, 230, 344
  - index tables, 341, 343, 350
  - Infiniband protocol, 47–48, 66, 86
  - Information Lifecycle Management (ILM), 395–396
  - Information Technology (IT), 196–197, 411–412
  - infrastructure servers, 13
  - initial copies, 260–261
  - initial switch setup
    - Brocade switch, 131–135
    - director switch, 135
    - overview, 130–131
  - initiators, 29, 188–189, 403
  - inode structures, 394
  - input/output (I/O) performance, 11
  - input/output (I/O) rates, 317
  - installation
    - drivers, 171
    - SANs, 300
  - instances, 184–185
  - Institute of Electrical and Electronics Engineers (IEEE) addresses, 72
  - integration labs, 86
  - Intel, 204
  - intercommunication, management software, 284–285
  - internal tape drives, 233
  - Internet Fibre Channel Protocol (iFCP), 211, 213–215, 219–220, 221
  - Internet Fibre Channel Protocol (iFCP)-based extenders, 203
  - Internet Protocol (IP), 8, 200–201, 205–206
  - Internet Protocol (IP) addresses, 164–166
  - Internet Small Computer Storage Interface (iSCSI) protocol
    - connectivity of, 203–204
    - data domains, 190
    - data routers, 38–39
    - HBAs, 86
    - initiators, 188–189
    - iSCSI qualified name, 189
    - as lower-cost solution, 416

- Internet Small Computer Storage Interface
    - (iSCSI) protocol (*continued*)
    - managing storage from central sites with, 411
    - overview, 47–48, 188, 223–224
    - SCSI Name Service, 189
    - setting up, 190–191
    - targets, 188–189
    - TCP off-load engine, 191
  - interoperability, application, 364
  - inter-switch links (ISLs)
    - congestion, 80
    - data transmission over, 167–169
    - in meshed fabric topology, 116
    - switch set up, 130, 163
    - in switched fabrics, 70, 71
    - terminology differences with, 89
    - trunking, 109
  - I/O (input/output) performance, 11
  - I/O (input/output) rates, 317
  - IP (Internet Protocol), 8, 200–201, 205–206
  - IP (Internet Protocol) addresses, 164–166
  - IQN (iSCSI qualified name), 189
  - iSCSI (Internet Small Computer Storage Interface) protocol
    - connectivity of, 203–204
    - data domains, 190
    - data routers, 38–39
    - HBAs, 86
    - initiators, 188–189
    - iSCSI qualified name, 189
      - as lower-cost solution, 416
      - managing storage from central sites with, 411
      - overview, 47–48, 188, 223–224
      - SCSI Name Service, 189
      - setting up, 190–191
      - targets, 188–189
      - TCP off-load engine, 191
  - iSCSI qualified name (IQN), 189
  - islands, SAN
    - creating SAN fabric from connected, 216–219
    - data copying, 199
    - disk/data sharing, 198–199
    - overview, 196–198
    - using connected, 219–220
  - ISLs (inter-switch links)
    - congestion, 80
    - data transmission over, 167–169
    - in meshed fabric topology, 116
    - switch set up, 130, 163
    - in switched fabrics, 70, 71
    - terminology differences with, 89
    - trunking, 109
  - iSNS service, 189
  - IT (Information Technology), 196–197, 411–412
- J •
- journaling writes, 359, 367–368
  - journals, CDP, 359–360, 365–366
- L •
- L\_Port, 44, 46
  - labeling, cable
    - data center coordinate system, 280–282
    - documenting cable arrangements, 283
    - overview, 85, 279–280
    - standard naming convention, 282–283
  - LAN (Local Area Network)
    - backups, 227–228, 233–234, 243–244
    - Gigabit Ethernet, 416
    - overview, 9
  - LAN-less backups, 231, 235–236
  - lasers, single-mode, 41
  - latency
    - director-class switches, 37
    - in disaster recovery, 142, 147–148
    - excess, 79–80
    - loop-of-switches topology, 114
    - rotational, 50
  - layer, fabric
    - cable-connector types, 43
    - cables, 40–42
    - components of, 15–16
    - data routers, 38–39
    - hubs, 30–33
    - overview, 29, 94
    - ports, 43–46
    - protocols used in Fibre Channel SAN, 46–48
    - storage fabrics, 29–30
    - switches, 33–37
    - using two, 138
    - virtualization, 383
  - layer, host
    - fiber-optic cables, 15
    - Gigabit Interface Connector, 15
    - Gigabit Interface Converter, 27–29
    - Gigabit Link Module, 27–29
    - host bus adapters, 15, 26–27
    - overview, 14, 26, 93–94
  - layer, storage
    - cache memory, 58–61
    - Logical Unit Numbers, 53–55
    - modular, 56–58

- monolithic, 56–57
  - overview, 16, 48, 94
  - RAID, 49–53
  - storage arrays, 48, 55–56
  - layers. *See also specific layers by name*
  - overview, 14, 23–26
  - storage arrays, 16–18
  - LC (Lucent connector) connectors, 29, 43, 108
  - leasing programs, 303
  - LEDs (light-emitting diodes), 28, 40, 311
  - Level 1, SLA service, 298
  - Level 2, SLA service, 298
  - Level 3, SLA service, 298
  - libraries, tape, 229, 231, 234–237
  - light-emitting diodes (LEDs), 28, 40, 311
  - linear operations, 248–249
  - links
    - IP connections, 205–206
    - OC connections, 206–208
    - overview, 204–205
  - listing services, 71
  - load balancing, 87–88, 111–112, 188
  - loading driver, 171
  - Local Area Network (LAN)
    - backups, 227–228, 233–234, 243–244
    - Gigabit Ethernet, 416
    - overview, 9
  - locking files, 414
  - log shipping, 151
  - logical cable management, 279
  - logical partitions (LPARs), 386–388
  - logical paths, in troubleshooting, 308
  - Logical Unit Number (LUN)
    - command devices, 290
    - creating for Unix servers, 175–176
    - direct mapping existing as virtual, 391–393
    - extent pool mapping, 394
    - multipathing, 184
    - overview, 49
    - partitions, 53–55
    - security, 161, 318–319
    - storage virtualization, 380, 390
  - Logical Units, 48
  - logout command, 134
  - long-wave fiber connections, 216–217
  - long-wave GBICs, 27–28
  - loop addressing, 69
  - loop devices, Fibre Channel, 100
  - loop IDs, 46, 69
  - loop ports, 44
  - loop topology, 95. *See also* arbitrated loop topology
  - loop-of-switches topology, 113–114
  - loops, 15, 30–32, 68–69, 80, 101
  - low-level languages, 18
  - low-level protocols, 67
  - LPARs (logical partitions), 386–388
  - LTO1-5 tape drives, 229
  - Lucent connector (LC) connectors, 29, 43, 108
  - LUN (Logical Unit Number)
    - command devices, 290
    - creating for Unix servers, 175–176
    - direct mapping existing as virtual, 391–393
    - extent pool mapping, 394
    - multipathing, 184
    - overview, 49
    - partitions, 53–55
    - security, 161, 318–319
    - storage virtualization, 380, 390
- M •
- macro-bends, 83–85
  - mail servers, 13
  - mainframes, 9, 55, 57, 196
  - MAN (metropolitan area network), 199–202
  - management, SAN
    - agent-based, 288
    - automation, 294–296
    - building SANs, 275–276
    - cable labeling, 279–283
    - cable management, 276–279
    - change management, 291
    - framework, 283–286
    - health monitoring, 289–290
    - overview, 273–275
    - predictions of problems, 292
    - records of events, 291
    - SLAs, 296–298
    - streamlining, 292–294
    - teams, 298–303
    - view of network, 287–288
  - management software, 76
  - manual set up, SAN, 158–159
  - manuals, 306–307
  - mapping, direct, 391–393
  - mapping zones, 180–181
  - maps, cable, 283
  - maximum queue depth, 82
  - Mbs (megabits), 66

- MBs (megabytes), 66
  - McData director switch, 135
  - MD5 (Message Digest Algorithm 5), 338
  - megabits (Mbs), 66
  - megabytes (MBs), 66
  - meshed fabric topology, 114–117
  - Message Digest Algorithm 5 (MD5), 338
  - metadata, 240–241, 337, 340
  - metadata copies, 256, 260
  - metropolitan area network (MAN), 199–202
  - micro-bends, 83–85
  - micrometers, 40
  - microscanning, 344–345
  - Microsoft, 204, 387
  - Microsoft iSCSI protocol support, 190
  - midrange-class arrays, 17, 60
  - midrange-class switches, 35–36
  - migration, data
    - backup/restore, 192
    - disk-to-SAN, 192
    - network, 192
    - overview, 191
  - mirrored cache, 60
  - mirroring, disk, 51
  - mirrors, splitting, 261–262
  - mixing switch vendors, 89–90
  - MM (multimode) cables, 40, 42, 82–83
  - modes of operation, SAN port, 44–46
  - modular class switches, 35–36, 106, 110–111
  - modular storage arrays, 16–18, 55–58, 60
  - monitoring levels, 289
  - monitoring team, SAN, 301
  - monolithic cache, 17
  - monolithic storage arrays, 16–18, 55–57, 60
  - multimode (MM) cables, 40, 42, 82–83
  - multipathing, 184
  - multipathing software, 186
  - multiple access paths, 10
  - multiple storage vendors, 137
  - multiple-port modular switches, 35
  - multiple-switch SAN fabrics, 312
  - multiplexed write operations, 359
- *N* •
- N\_Port, 44–45
  - name servers, 47
  - Name Service, SCSI, 189
  - names
    - fabric, 167
    - switch, 132, 163
  - naming convention, cable, 282–283
  - nanometers, 27
  - near CDP, 370
  - Network Attached Storage (NAS),
    - 14, 30, 220–222, 413–414
  - Network File System (NFS) protocol,
    - 220–221, 413
  - network layer, 383
  - network migration, 192
  - Network Operations Center (NOC), 301
  - Network Storage Servers (NSS), 384
  - networking SANs
    - bandwidth, 66
    - cost reduction, 208–211
    - creating SAN fabric from two connected
      - SAN islands, 216–219
    - fiber-optic cables, 64–65
    - Fibre Channel protocols, 67–69
    - Internet Small Computer Storage
      - Interface, 223–224
    - links, 204–208
    - MAN, 199–202
    - NAS, 220–222
    - overview, 63–64
    - protocols, 211–215
    - SAN extenders, 202–204
    - SAN islands, 196–199, 219–220
    - for storage management, 200–201
    - SWAN, 199–202
    - switched fabric, 70–74
    - WAN, 199–202
  - networks
    - bandwidths, 145–146
    - components, 15–16
    - corporate, 231, 234
    - in disaster recovery facilities, 149
    - hub-based, 59
    - Internet Protocol, 8
    - with SAN management platform, 287–288
    - switched-based, 59
  - NFS (Network File System) protocol,
    - 220–221, 413
  - 9µm cables, 40–42, 82–83, 216, 311
  - NL\_Port, 44–45
  - No Single Point of Failure (NSPOF) features,
    - 105–106
  - NOC (Network Operations Center), 301
  - node ports, 44
  - node-to-loop ports, 44
  - non-blocking architecture, 59
  - non-blocking devices, 70, 95
  - non-blocking switches, 33

Nortel Networks, 203  
 NSPOF (No Single Point of Failure)  
   features, 105–106  
 NSS (Network Storage Servers), 384  
 numbering cables, 281–282

## • 0 •

obvious problems  
   broken cables, 311–312  
   broken fabric switch, 312–313  
   broken HBA, 314  
   broken server, 315–316  
   broken storage array, 314–315  
   overview, 310–311  
 OC (optical carrier) connections  
   dark fiber, 207–208  
   Dense Wave Division Multiplexing, 207  
   overview, 206  
 100Base-T networks, 244  
 1000Base-T networks, 244  
 online recovery, 10  
 operating systems (OSs), 21, 151, 261  
 optical carrier (OC) connections  
   dark fiber, 207–208  
   Dense Wave Division Multiplexing, 207  
   overview, 206  
 optical media, 238  
 OSs (operating systems), 21, 151, 261  
 out-of-band de-duplication, 346–347  
 out-of-band management, 289–290  
 out-of-band virtualization, 400–401  
 out-of-band write splits, 360–361  
 over-subscription, 81–82

## • p •

pairs, 259–261, 267–268  
 parity drives, 52–53  
 parity information, 49  
 parking, disaster recovery facility, 149  
 partitions  
   disk, 53–55  
   logical, 386–388  
 passwords, Telnet session, 131–132  
 patch panels, 78, 83–85, 277–278  
 path fail-over software, 87–88, 111–112, 188,  
   385  
 path-management software, 112–113  
 paths, LUN, 175–176  
 PBs (petabytes), 229

performance  
   for applications, 412  
   issues with, 319–321  
   with RAID, 49  
   SAN, 10–11  
 performance analysis, 320  
 performance specialists, 301–302  
 persistent binding, 184  
 personal computers, 13  
 petabytes (PBs), 229  
 phantom problems  
   faulty HBA drivers, 317–318  
   faulty HBAs, 316–317  
   overview, 310, 316  
 Phone Home, 57  
 physical cable management, 277–278  
 physical layer, 8  
 PiT (Point-in-Time) copies  
   automation of, 295  
   backups, 248–249  
   complete copies, 254–256  
   copies, using, 264  
   corruption-recovery images, 250–251  
   creating, 257–258  
   disk storage for, 268–269  
   metadata copies, 256  
   other uses for, 252–253  
   overview, 232, 247–248, 259  
   pairing volumes, 259–260  
   pairs, 260–261, 267–268  
   questions for vendors, 270  
   quick restores, 263–264  
   refreshing, 262–263  
   restoring, 262–263  
   resynchronization, 262–263  
   saving space, 251–252  
   snapping copies, 261–262, 265–266  
   splitting mirrors, 261–262  
 Plain Old Telephone Service (POTS)  
   lines, 205  
 plans, SAN  
   LUN security, 161  
   overview, 159–160  
   zoning, 160–161  
 platforms  
   applications that benefit from SAN, 21–22  
   applications that require SAN, 22  
   overview, 20–21  
 players, 20  
 Point-in-Time (PiT) copies  
   automation of, 295  
   backups, 248–249

- Point-in-Time (PiT) copies (*continued*)
    - complete copies, 254–256
    - copies, using, 264
    - corruption-recovery images, 250–251
    - creating, 257–258
    - disk storage for, 268–269
    - metadata copies, 256
    - other uses for, 252–253
    - overview, 232, 247–248, 259
    - pairing volumes, 259–260
    - pairs, 260–261, 267–268
    - questions for vendors, 270
    - quick restores, 263–264
    - refreshing, 262–263
    - restoring, 262–263
    - resynchronization, 262–263
    - saving space, 251–252
    - snapping copies, 261–262, 265–266
    - splitting mirrors, 261–262
  - point-to-point topology, 95–98
  - policies, backup, 230
  - pools, storage, 382, 396–397
  - port blades, 36, 107
  - port names, 45, 128
  - ports
    - arbitrated loop topology, 99
    - configuration of arrays, 173
    - Fibre Channel, 97
    - hard zoning, 127
    - maximum queue depth, 82
    - overview, 15
    - resilient connections, 103
  - postprocess data de-duplication, 346
  - POTS (Plain Old Telephone Service)
    - lines, 205
  - prediction, of problems, 292
  - preparing servers
    - HBA card configuration, 171
    - HBA connections, 171–172
    - loading driver, 171
    - overview, 170
  - primary disks, 372–373
  - primary volumes, 259
  - principal switches, 217
  - proactivity, 309
  - problems. *See* troubleshooting
  - processor blades, 36
  - production databases, 356
  - propagation, 167
  - proprietary functionality, 90
  - protection, data
    - near CDP, 370
    - overview, 368
    - snapshots, 370
    - traditional backups, 369
    - true CDP, 370–371
  - protocol stack, 8
  - protocols. *See also* Fibre Channel (FC) protocol
    - CIFS, 220–221, 413
    - defined, 64
    - FC-AL, 18, 31, 46, 68–69
    - FCIP, 211–213
    - FC-SW, 18, 46
    - FTP, 192, 312–313
    - high-level, 67
    - iFCP, 211, 213–215, 219–221
    - Infiniband, 47–48, 66, 86
    - IP, 8, 205–206
    - iSCSI, 47–48, 86, 188–191, 203–204, 411, 416
    - low-level, 67
    - need for, 71–72
    - NFS, 220–221, 413
    - SCSI, 18–20, 47
    - SNMP, 301, 332
    - SOAP, 285
    - TCP/IP, 9
    - types of, 18–20
  - provisioning, 294
  - provisioning staff, 302
- *Q* •
- QLogic, 86–87, 89, 203
  - QLogic switches, 131
  - quick restores, 263–264
  - quiescing process, 265–266
- *R* •
- R1 (replica) copies, 372–374
  - rackmount panels, 277
  - RAID (Redundant Array of Independent Disks)
    - benefits of, 49–50
    - overview, 49, 60
    - PiT pairs, 267
    - RAID 0, 50
    - RAID 1, 51
    - RAID 1+0, 51
    - RAID 2, 52
    - RAID 3, 52
    - RAID 4, 52
    - RAID 5, 52, 174

- RAID 6, 53
- RAID 10, 174
- SAN connectivity, 25
  - setup, 174–177
  - types of, 49, 50–53, 76
- random-access media, 226
- reactivity, 309
- receivers, 64
- records of events, 291
- recovery, CDP, 367
- recovery, database
  - near CDP, 370
  - overview, 368
  - snapshots, 370
  - traditional backups, 369
  - true CDP, 370–371
- recovery, online, 10
- Recovery Point Objective (RPO), 141
- recovery sites
  - co-location facility, 150
  - existing facility, 149–150
  - overview, 148–149
- Recovery Time Objective (RTO), 141
- redundancy, 101, 168
- redundancy features, monolithic storage, 57
- Redundant Array of Independent Disks (RAID)
  - benefits of, 49–50
  - overview, 49, 60
  - PiT pairs, 267
  - RAID 0, 50
  - RAID 1, 51
  - RAID 1+0, 51
  - RAID 2, 52
  - RAID 3, 52
  - RAID 4, 52
  - RAID 5, 52, 174
  - RAID 6, 53
  - RAID 10, 174
  - SAN connectivity, 25
    - setup, 174–177
    - types of, 49, 50–53, 76
- refreshing PiTs, 262–263
- reliability, 11
- remote backups, 232, 242
- remote copy solutions, 148
- remote offices, 417–418
- remote sites, 143
- replacement, switch, 313
- replica (R1) copies, 372–374
- replication, data. *See* data replication
- resilience, meshed fabric, 116
- resilient hub networks, 102–103
- restoration, PiT, 262–263
- restores, migration, 192
- resynchronization, 262–263
- retention schedule, 352
- return-on-investment (ROI) reports, 414
- robotic tape libraries, 234
- rolled back updates, 358
- rolling disasters, 364
- rotating PiT copies, 250–251
- rotational latency, 50
- routers, 16
- routing communication sessions, 71
- RPO (Recovery Point Objective), 141
- RTO (Recovery Time Objective), 141
- rubber-band approach, 213, 216
- Rule of 16, 12

## • S •

- SA codes, 282
- SAN extenders. *See* extenders, SAN
- SAN fabric. *See* fabric layer
- SAN fabric switches. *See* fabric switches
- SAN hubs. *See* hubs
- SAN islands
  - creating SAN fabric from connected, 216–219
  - data copying, 199
  - disk/data sharing, 198–199
  - overview, 196–198
  - using connected, 219–220
- SAN layers. *See* layers
- SAN ports
  - modes of operation, 44–46
  - naming, 43
- SAN switches. *See* switches
- SAN Volume Controller (SVC), 384
- SAN-management software, 200, 202
- SANs (storage area networks)
  - benefits of, 10–11
  - computing with, 9–10
  - fabric layer, 15–16
  - fibres, 8–9
  - host layer, 14–15
  - overview, 7–8, 14
  - platforms, 20–22
  - players, 20
  - protocols, 18–20
  - storage arrays, 16–18
  - storage layer, 16
  - users, 12–14

- SC (Subscriber connector) connectors, 28, 43, 108
- scaling up, 113
- SCSI (Small Computer Storage Interconnect) devices, 39
- SCSI (Small Computer Storage Interconnect) disk drives, 25–26
- SCSI (Small Computer Storage Interconnect) inquiry strings, 393
- SCSI (Small Computer Storage Interconnect) Name Service, 189
- SCSI (Small Computer Storage Interconnect) protocol, 18–20, 47
- SCSI (Small Computer Storage Interconnect) target 1, 185
- SCSI (Small Computer Storage Interconnect)-connected disks, 10
- SDLT tape drives, 229
- secondary volumes, 259
- Secure Hash Algorithm (SHA), 338
- securelun parameter, arraycfg command, 176
- security
  - data, 71
  - Logical Unit Number, 161, 318–319
- security access, disaster recovery facility, 149
- seek time, 50
- self-tests, HBA, 316
- sequential mediums, 226
- Serial ATA disks, 267, 269
- server clusters, 11, 199
- server creep, 409
- server virtualization, 22, 386–388
- server-class computer applications, 21
- serverless backups, 231, 236–237
- servers
  - backups on, 232–234
  - components of SANs, 159
  - consolidation, 409–410
  - with expanding disk-storage needs, 21
  - overview, 183–184
  - preparation of, 170–172
  - recovery of critical applications, 144
  - reduction of, 10–11
  - resources, 12–14
  - Rule of 16, 12
  - sharing storage arrays with SAN hubs, 31
  - tape drives in, 231
  - troubleshooting, 315–316
  - Unix, 184–187
  - virtual, 384
  - Windows system, 187–188
  - without SANs, 414
- service enabling, 391–392
- Service Level Agreement (SLA)
  - management teams, 301–302
  - overview, 296
  - setting service levels, 298
  - simple versus complex, 297
- service levels, 298
- sessions, 189
- setup
  - documentation, 162
  - manual, 158–159
  - overview, 162
  - switches, 130–135, 162–170
- SHA (Secure Hash Algorithm), 338
- sharing, disk, 198–199
- shipping tapes, 155–156
- short-wave GBICs, 27
- signal loss, 78–79
- signatures, 123–124, 187
- Simple Network Management Protocol (SNMP), 301, 332
- simple SLAs, 297
- single-mode environments, 41
- single-mode lasers, 41
- single-server zones, 137
- sites, recovery
  - co-location facility, 150
  - existing facility, 149–150
  - overview, 148–149
- 16-port modular-class switches, 35, 106
- 62.5 $\mu$ m SM cables, 41–42, 82–83
- sizing CDP journals, 365–366
- SLA (Service Level Agreement)
  - management teams, 301–302
  - overview, 296
  - setting service levels, 298
  - simple versus complex, 297
- Small Computer Storage Interconnect (SCSI) devices, 39
- Small Computer Storage Interconnect (SCSI) disk drives, 25–26
- Small Computer Storage Interconnect (SCSI) inquiry strings, 393
- Small Computer Storage Interconnect (SCSI) Name Service, 189
- Small Computer Storage Interconnect (SCSI) protocol, 18–20, 47

- Small Computer Storage Interconnect (SCSI)
  - target 1, 185
- Small Computer Storage Interconnect (SCSI)-connected disks, 10
- SMI (Storage Management Initiative), 285
- snapping copies, 261–262, 265–266
- snapshot pool, 241
- snapshots, 231–232, 240–241, 364–366, 370–373
- SNIA (Storage Networking Industry Association), 20, 44, 204, 285, 380
- SNMP (Simple Network Management Protocol), 301, 332
- SOAP (Standard Object Access Protocol), 285
- soft zoning, 126–127, 160
- software
  - backup, 22, 236, 251, 418
  - EFC Manager, 135
  - fail-over filter drivers, 112
  - management, 76
  - multipathing, 186
  - path fail-over, 87, 111–112, 188
  - path-management, 112–113
  - SAN management, 200, 202, 284
  - SLA management, 297
  - storage-management, 61
  - third-party backup, 232–233
- software drivers, HBA, 27
- software-based PiT copies, 257–258, 269
- software-based recovery solutions, 415
- software-based server virtualization, 387–388
- software-based storage virtualization
  - vendors, 402
- space
  - disaster recovery facility, 149
  - saving, 251–252
- speed
  - of backups, 236, 242–246
  - of connections, 145–146
  - copying, 207–208
  - data transfer, 29
  - of hubs, 32
  - of switches, 108
  - tape drives, 229
- splitting mirrors, 261–262
- stacks, 8
- staff
  - disaster recovery, 144
  - monitoring, 301
  - utilization, 11
- standard naming convention, cable, 282–283
- Standard Object Access Protocol (SOAP), 285
- standardization
  - firmware versions, 136
  - HBA drivers, 137
  - vendor switches, 136
  - vendors, 86–88
- star ring topology, 118–119
- star topology, 117–119
- status lights, component, 308
- storage
  - CDP best practices, 367–368
  - database-like, CDP, 358–366
  - on demand, 11
  - disk, 268–269
  - internal, 13
  - managing from central site, 410–411
  - space on servers, 409
- storage area networks (SANs)
  - benefits of, 10–11
  - computing with, 9–10
  - fabric layer, 15–16
  - fibres, 8–9
  - host layer, 14–15
  - overview, 7–8, 14
  - platforms, 20–22
  - players, 20
  - protocols, 18–20
  - storage arrays, 16–18
  - storage layer, 16
  - users, 12–14
- storage arrays
  - classification, 55–56
  - components of SANs, 159
  - differences between, 59
  - modular arrays, 17–18
  - monolithic arrays, 17–18
  - overview, 16, 48
  - troubleshooting, 314–315
- storage fabrics, 29–30
- storage layer
  - cache memory, 58–61
  - Logical Unit Numbers, 53–55
  - modular, 56–58
  - monolithic, 56–57
  - overview, 16, 48, 94
  - RAID, 49–53
  - storage arrays, 48, 55–56
  - virtualization, 383
- Storage Management Initiative (SMI), 285
- Storage Networking Industry Association (SNIA), 20, 44, 204, 285, 380
- storage networks, 30

- storage virtualization
  - direct mapping existing LUN as
    - virtual LUN, 391–393
  - extent pool mapping, 394
  - overview, 389–391
  - using for better performance, 395–397
  - virtual disks, 391
  - virtual tapes, 397–398
- storage wide area network (SWAN), 196, 199–202
- storage-array-based virtualization, 402–403
- storage-based de-duplication, 339
- storage-management software, 61
- streamlining SAN management
  - overview, 292
  - step-by-step administration, 292–293
  - using framework, 293–294
- stretched-rubber-band approach, 216
- striping, disk, 50, 52
- sub-block-level delta versioning, 344–345
- sub-block-level hashing, 341–343, 348–350
- Subscriber connector (SC) connectors, 28, 43, 108
- Sun Microsystems, 377, 387
- SVC (SAN Volume Controller), 384
- SW codes, 282
- SWAN (storage wide area network), 196, 199–202
- swaps, 263–264
- switch architecture arrays, 59
- switch commands, 129–130, 132–135, 165, 312
- switch ports, 44
- switch vendors, mixing, 89–90
- switched fabric
  - choosing switches, 107–108
  - fabric addressing, 72–74
  - fabric protocol, 71–72
  - FC-SW protocol, 46
  - overview, 29–30, 70–71, 95, 105–106
  - trunking, 108–110
  - types of SAN switches, 106–107
  - using right bandwidth, 108
  - zoning, 123
- switched-based networks, 59
- switchEnable command, 134
- switches. *See also* Brocade switches
  - bottlenecks with, 320, 321
  - compared to hubs, 32
  - configuring, 164–166
  - connecting SAN fabrics, 219
  - connectivity, verifying, 166
  - core-edge topology, 119–120
  - director-class, 36–37, 105–106
  - extending SAN fabrics, 217
  - fabric, 159, 163, 166–170, 312–313
  - iFCP devices to replace, 221
  - management functions, 311
  - in meshed fabric topology, 116
  - overview, 15, 33–35, 60
  - setup, 130–135
  - standard modular, 35–36
  - star topology, 117–118
  - types of, 106–108
- SwitchShow command, 178
- switch-to-switch expansion ports, 44
- Symantec, 320, 377
- synchronized volumes, 261
- synchronous data transmission, 147
- synchronous remote copy solutions, 148

## ● T ●

- T\_Port, 44, 46
- tag numbers, asset, 282–283
- tape backups, 199, 372
- tape drives, 226, 228–229, 231–234, 236, 245–246
- tape libraries, 229, 231, 234–237
- target ports, 188
- targets, 29, 188–189, 403
- TCP/IP (Transmission Control Protocol/Internet Protocol), 9
- TCP/IP (Transmission Control Protocol/Internet Protocol) addresses, 163–164
- TCP/IP Offload Engine (TOE), 191, 204, 416
- TCP/IP Offload Engine (TOE) adapters, 86
- TCP/IP Offload Engine (TOE) network adapter cards, 191, 223
- teams, SAN management
  - architects, 299–300
  - common responsibilities, 303
  - engineers, 300
  - monitoring team, 301
  - overview, 298–299
  - performance specialists, 301–302
  - planning for future, 302–303
  - provisioning staff, 302
  - Service Level Agreement, 301–302
- tech support, 307

- Telcos, 202
  - telnet commands, 164, 181
  - Telnet sessions, 131–132
  - 10Base-T networks, 244
  - terabytes, 207
  - testing
    - application, 253
    - recovery, 156
  - third-party backup software, 232–233
  - third-party copies, 237
  - 32-port modular switches, 106
  - tiered backup design, 238–239
  - TOE (TCP/IP Offload Engine), 191, 204, 416
  - TOE (TCP/IP Offload Engine) adapters, 86
  - TOE (TCP/IP Offload Engine) network adapter cards, 191, 223
  - topologies
    - arbitrated loop, 98–105
    - basic fabric, 110–122
    - overview, 95
    - point-to-point, 96–98
    - switched fabric, 105–110
  - T-ports, 89
  - track change tables, 262
  - track pointers, 254–255
  - training classes, 303
  - transaction logs, 358–359
  - transactions, 358–359
  - transceivers, 27
  - Transmission Control Protocol/Internet Protocol (TCP/IP), 9
  - Transmission Control Protocol/Internet Protocol (TCP/IP) addresses, 163–164
  - transmitters, 64
  - trends, SAN, 292
  - troubleshooting
    - catastrophic problems, 322
    - causes of SAN problems, 75–76
    - continuous problems, 318–321
    - methodology, 306–310
    - obvious problems, 310–316
    - phantom problems, 316–318
    - prevention, 306
    - scenario #1, 323–325
    - scenario #2, 326–328
    - scenario #3, 328–332
    - with switches' name server information, 74
  - true CDP, 370–371
  - Trunk ports, 44
  - trunking, 89, 108–110, 168
  - tunnel approach, 211–213
  - 24-port modular switches, 106
  - twist-tie wraps, 83
  - 2-Gbit Fibre Channel SAN networks, 244
- U •
- Unisys, 387
  - Universal Storage Platform (USP), 384, 393, 402–403
  - Unix servers
    - load balancing, 186
    - moment of truth, 186–187
    - overview, 161, 184
    - path fail-over software, 186
    - persistent binding, 184–186
  - updates, BIOS firmware, 27
  - upgrades, network, 11, 303
  - uptime, 297
  - usernames, Telnet session, 131–132
  - users, SAN, 12–14
  - USP (Universal Storage Platform), 384, 393, 402–403
- V •
- vendors
    - CDP, 376–377
    - data de-duplication, 339
    - documentation from, 307
    - DWDM solutions, 203
    - fabric-based virtualization storage vendors, 402
    - FCIP solutions, 203
    - hardware-based server virtualization, 387–388
    - HBA, 27, 86–87
    - HBA configuration files from, 317
    - HBA testing by, 316, 318
    - host-based storage virtualization, 401–402
    - installing SANs, 300
    - iSCSI solutions, 204
    - metadata PiT implementation requirements, 256
    - path-management software, 113
    - PiT copies, 261, 270
    - SAN design by, 135
    - SAN management packages, 320
    - software-based server virtualization, 387–388
    - speed of de-duplication, 348

- vendors (*continued*)
  - standardizing switches, 136
  - storage-array-based virtualization, 402–403
  - switch, 130–131, 312
  - training by, 303
- Veritas volume manager (VxVM), 384
- video servers, 13
- virtual disks, 391
- virtual file systems, 384
- Virtual Iron, 387
- virtual LANs (VLANs), 383
- virtual LUNs, 391–393
- virtual servers, 384
- Virtual Tape Libraries (VTL), 231, 238, 375, 398
- virtual tapes, 397–398
- virtual WWNs, 72
- virtualization
  - implementing in datacenter, 383–386
  - in-band, 399–400
  - out-of-band, 400–401
  - overview, 379–380
  - server, 22, 386–388
  - storage, 389–398
  - types of, 381–382
  - vendors, 401–403
- VLANs (virtual LANs), 383
- VMware, 387
- voice servers, 13
- volumes, pairing, 259–260
- VTL (Virtual Tape Libraries), 231, 238, 375, 398
- VxVM (Veritas volume manager), 384

## • W •

- WAN (wide area network), 199–202
- WAN (wide area network) tuners, 211
- wavelengths, of light, 42
- Web Based Enterprise Management (WBEM), 285
- Web servers, 13
- white space, 345
- wide area network (WAN), 199–202

- wide area network (WAN) tuners, 211
- window, backup, 227–228
- Windows servers, 161
- Windows system, 187–188
- wiring closets, 85
- World Wide Name (WWN)
  - overview, 46–47
  - RAID setup, 175–177
  - soft zoning, 126–127, 128
  - swapping when replacing HBAs, 314, 315
- World Wide Node Name (WWNN), 47, 72
- World Wide Port Name (WWPN),
  - 47, 72–73, 184
- WORM (Write Once Read Many) storage,
  - 238, 355
- write data, 209
- write splitting, 360–362
- WWN (World Wide Name)
  - overview, 46–47
  - RAID setup, 175–177
  - soft zoning, 126–127, 128
  - swapping when replacing HBAs, 314, 315
- WWNN (World Wide Node Name), 47, 72
- WWPN (World Wide Port Name),
  - 47, 72–73, 184

## • Z •

- zone aliases, 127–130, 137, 160
- zone configuration, 125, 170
- zone sets, 125, 160, 170, 180
- ZoneCreate command, 182
- zonestow command, 183
- zoning
  - changes, 318
  - configuring, 180–183
  - hard, 127
  - overview, 123–125
  - parts of zone, 125–126
  - setup, 160–161
  - soft, 126–127
  - zone alias names, 127–130