# Index


Access control lists (ACLs), 62–63
Advanced intelligent tape (AIT), 21
Advanced Technology Attachment (ATA) drives, 72
AIT-3 (Sony), 146
Application deployment, 194–196
  rapid response model, 196
  transitioning between systems, 194–195
Application efficiency, 6
Application layer, 160–161
Application servers, 92
Assets, identifying, 325
Asynchronous mirroring, 258–259
Asynchronous replication, 73–74
  writes under, 159
AT&T, 257
ATA (Advanced Technology Attachment), 17
ATM, 34
Attribute-based storage:
  access/topology, 99
  locations for storage services, 100
  managing, 99–100
  reactive capability, 99
  visibility, 99
Audience, 7–8
Authentication, 61–63
  policies, 59
  and storage policy management, 61–62
Automated offsite backup, 313–314
Automated tape libraries, 19
Availability, 3–4, 88
  appropriate level of, 143
  and data storage, 3–5

Backup and restore, 179, 280, 312–318
  automated offsite backup, 313–314
  full backup, 145
  incremental backup, 145
  offsite tape backup storage, 313
  remote, 180
  remote disk mirroring, 315–317
  split-site server array, 314–315
  strategy, 312–18
Basic storage building blocks, 14–16
Best-practice storage deployments, 3–4
  agility/competence of the system, 4
  availability, 3–4, 88
  utilization, 3
Billing systems, 66
Bits per second (bps), 232–233
Blade servers, 203
Block-accessed SANs, 302
Blocks, 14–16
Bottlenecks, 85, 94
Broad view storage perspective, 333–359
  battle areas, 339
  challenges faced by NAS incumbents, 349
  characteristic market dynamics, 344, 351, 358
  end-to-end vendor solutions, increases in:
  Fibre Channel, 355
  innovation, 338
  investment and M&A trend summary, 346, 353
  market fundamentals, 341
  market segmentation:
    storage components, 357
    storage systems, 350
  network intelligence, 348
  networked storage market, leaders in, 356
  segment focus, 342
  software and systems vendors, 345

Broad view storage perspective (*cont.*)
storage capacity demands and budgetary constraints, 337
storage components:
market map, 359
and semiconductors, 354
storage management:
market map, 345
market segmentation, 343
storage market drivers/valuation considerations, 336
storage systems, 347
market map, 352
Building blocks, storage, 14–16
Business application architecture, 165–166
Business continuity, 280
corporate systems, 165–168
business application architecture, 165–166
call centers, 168
e-commerce, 167
email, 167
enterprise applications, 167
external Web sites, 166–167
internal Web sites, 167
storage redundancy layers, using, 168
data center, availability within, 145–155
disaster tolerance and recovery, 155–165
data replication, 158–164
offsite media vaulting and recovery, 155–157
recovery, 164–165
remote mirroring and failover, 157–158
expectations, 5
factors affecting choice of solution, 143–145
for mission-critical applications, 139–170
objectives, assessing, 141–145
recovery point objective (RPO), 142–143
recovery time objective (RTO), 142
Business management, 278–279
policies, 283–285
monitoring/reporting, 283
reliable service, 283
vendor selection, 283–285
Bytes per second (bps), 233

CA Brightstor, 67
Call centers, 168
Capacity, 87
Capacity efficiency, 6
Capacity management, 60–61
Capacity planning, 55
Capacity policies, 59
Cargo and data transport analogies, 231–232
"Case for Redundant Arrays of Inexpensive Disks, A" (Patterson/Gibson/Katz), 147
Central office (CO), 242
Centralization, 191–192
asset tracking, 192
change management, 192
event management, 192
network, 122–124
problem management, 192
quality assurance, 191–192
service-level agreements (SLAs), 191–192
Certification, and service-level agreements (SLAs), 189–190
Client-server computing, 91–92
Clustering, 152–155
and high availability, 152–155
and minicomputers, 90–91
Cold recovery site, 320
Common Information Model (CIM), 47
Common Interface Model (CIM), 300
Common IP network vs. common technology, 128–129
Communication mechanisms, 328–331
Competitive local exchange carriers (CLECs), 244
Complete outsourcing, 177–178
Complexity, 144
Computer resources, gap between, 102
Congestion delay, 256
Congestion queuing models, 264
Content management, 60–61
Context, managed, 275
Context overload, 275
Contracted disaster recovery company, 321
Core service offerings:
outsourced storage, 178–181
primary storage area network (SAN), 178
primary network-attached storage, 178–179
remote network-attached storage, 180
remote storage area network (SAN), 180
Corporate asset management, 196
Corporate data, capitalizing, 196
Corporate systems:
business application architecture, 165–166
call centers, 168
e-commerce, 167
email, 167
enterprise applications, 167

external Web sites, 166–167
internal Web sites, 167
storage redundancy layers, using, 168
Corporations:
information generated by, 1–2
information technology (IT) operations, 2
Credit spoofing, 254
CRM, 91, 167
Customer located equipment (CLE), use of term, 243
Customer resource management (CRM) software, 91, 167
Cyclical Redundancy Check (CRC), 90

DAS, *See* Direct-attached storage (DAS):
Data center, 145–155, 235
availability across geographies, 155–165
availability within, 145–155
backup and restore, 145–147
high availability/clustering, 152–155
point-in-time copies, 150–152
quick recovery file systems, 150
RAID (Redundant Array of Inexpensive Disks), 147–150
Data compression, 245
Data consistency chart, 160–161
Data coordination, 56–58
file services for NAS, 56–57
storage aggregation, 58
volume management, 57–58
Data corruption, 150–152
Data management, 281–282
policies, 286–287
availability/performance requirements, 287
content distribution guidelines, 287
copy functions, 286
data migration, 287
data retention, 287
file systems, 287
storage growth and allocation, 287
Data Manipulation Language (DML), 162
Data mirroring, 253
types of, 258–259
Data Mobility Group, 276
Data protection, 66–72
disk backup and recovery, 69–70
hierarchical storage management (HSM), 71–72
point-in-time and snapshot copy, 70–71
tape-based backup, 67–69
Data replication, 158–164
methods of, 160–164
application layer, 160–161
database layer, 162
file system layer, 162–163
logical volume manager layer, 163
storage array layer, 163–164
modes of, 158–160
remote, 253
technology behind, 255–258
Data storage:
architectural landscape, 13–42
business continuity, need for, 4–5
concept of, 2
and direct-attached storage (DAS), 15–16, 22
external storage, 17–22
independent plans/strategies, development of, 6–7
infrastructure investment in, 5
internal/server-based storage, 17
network-attached storage (NAS), 22–26
operational agility, 4, 5–6
optical storage, 21–22
solid-state storage, 21–22
storage networking roadmap, charting, 6–7
target audience, 7–8
Data storage application, classifying across core and context, 273
Database layer, 162
Database Management Systems (DBMS), 15
Database servers, 92
Declassifying storage networking, 302–304
Defensive strategies, 115–120
availability/protection with remote SAN topologies, 117–118
budget reduction and human capital protection, 118–120
data availability, 115–117
data availability and remote site storage user diagram, 118
Delay:
congestion, 256
insertion, 256
node, 256, 264
processing, 263
propagation, 256, 264
queuing, 256, 264
store-and-forward, 256
switching, 256
Deliverables, 86–88

Dell, 3
Demand, unforeseen, meeting, 121
Demarcation point, 233
Dense Wave Division Multiplexing (DWDM), 28, 34, 36, 117–118
Departmental segmentation/accounting, 66
Deployment, 6
  application deployment, 194–196
  best-practice storage deployments, 3–4
  data management policies, 286–287
  infrastructure design shifts, 202–207
  initiating, 201–228
  IP storage networks scenarios, 211–216
  IT deployment:
    effective migration, designing, 209–210
    improvement costs, minimizing, 207–209
    IT portfolio, managing, 211
    qualifying/quantifying, 207–211
    return on investment (ROI), calculating, 210–211
    total cost of ownership (TCO), calculating, 210–211
  network storage deployments, 229
  operational efficiency:
    email storage case study, 219–221
    fixed-content storage networking, 217–218
    imaging fixed content, 221–222
    maximizing, 216–224
    ten-thousand-dollar terabyte, achieving, 222–224
  optimized storage deployment, 4
*Designing Storage Area Networks* (Clark), 26
Device block aggregation, 16
Device interconnects, 203
Device management, 54
Digital Equipment Corporation (DEC), 90
Digital linear tape (DLT), 21
Direct-attached storage (DAS), 15–16, 22–23, 25, 119, 234, 302
Disaster recovery, 280
  scenarios, 286
Disaster tolerance and recovery, 155–165
  data replication, 158–164
  offsite media vaulting and recovery, 155–157
  remote mirroring and fallover, 157–158
  secondary site, 164–165
Discovery, 47–48
Disk arrays, 95
Disk backup and recovery, 69–70
Disk drives, 202
Disk mirroring, 150–151, 157
Distances, 328–331
Distributed architecture paradigm, 307, 311
Distributed systems, building blocks of, 101–103
  strategy, 311–312
    blurring roles, 312
    documentation volume increases in, 311–312
    new IT service recovery model, 312
Distributed Web servers, 92
Downtime, 4–5, *See also* Business continuity
DRM (HP/Compaq), 34
DWDM, *See* Dense Wave Division Multiplexing (DWDM)

E-commerce, 167
EDS, 177
Effective migration, designing, 209–210
Electronic data interchange (EDI), 298
Email, 167
Email storage case study, 219–221
EMC Corporation, 2–3
  Centera line, 204
  SRDF, 34
Encryption, storage, 62–64
End-to-end storage infrastructure:
  device interconnects, 203
  disk drives, 202
  fluidity of, 202–204
  intelligent storage nodes, 202–203
  I/O interconnects, 203
  network, 203
Enterprise applications, 167
Enterprise Resource Planning (ERP) applications, 91, 167
Equipment choice, providing, 121–122
Ethernet, 23, 28–29, 30, 33, 36, 48, 102, 103–105, 123, 128, 129–130, 230
Ethernet Local Exchange Carriers (ELECs), 233
Ethernet/IP, compared to Fibre Channel fabrics, 30–31
Event and error tracking, 50–51
Extensible Markup Language (XML), 47
External storage, 17–22
  just a bunch of disks (JBOD), 16, 17–18
  RAID levels, 19–20
  redundant array of independent disks (RAID), 16, 17–19
  tape drives and tape libraries, 19–21
External Web sites, 166–167

Fabric virtualization, 78–80
  types of, 78–79
Failover mechanisms, 154
Failover technologies, 157
Fast Ethernet, 233
Fast-start TCP, 267
FCIP (Internet Fiber Channel Protocol), 38, 42, 51, 239
Fibre Channel, 16, 18, 22, 25–26, 102, 120, 157–158
  backbone circuit, cost of, 236
  -based storage networks, 62
  cabling, 22
  compared to Ethernet/IP fabrics, 31
  defined, 26
  directors, 117
  encryption, 247
  end devices, 42–43
  fabrics, 42, 246
    compared to Ethernet/IP, 30–31
  HBAs, 31–32, 125, 127, 247, 266
  interface cards for multiplexers, 235
  linking to Fibre Channel with IP, 34–36
  loop, 18
  MAC, 247
  network, 117, 132
  networks, 26, 28
  RAIDs, 39
  SANs, 27–28, 30, 33–35, 123, 125, 239
    and data center environments, 30
    enhancing with IP, 33-34
  SANs and devices, linking with IP networks, 35
  storage area networks, 27
  storage deployment options, 39–40
  switch technology, 253
  switches, 105, 254
  using IP to enhance, 34–35
Fibre Channel over IP, 38
Fibre Channel Protocol (FCP), 26–27
  basics of, 27
File services for NAS, 56–57
File system layer, 162–163
File systems (FS), 14–15
File-accessed SANs, 302
Filer, 23
Firewalls, 247
Fixed content, imaging, 221–222
Fixed-content storage networking, 217–218
Flexible SANs, 121–122
Fluid environment, migrating storage functions in, 205–206
Forwarding Information Base (FIB), 94
Frame Relay, 34
Freedom Data Storage (Hitachi Data Systems), 3
Free-space optical systems, 245
Free-space pool, 300
Frozen image copy, 147
Full backup, 145
Function-specific storage nodes, 297

Gibson, Garth A., 19, 147
Gigabit Ethernet, 22, 39, 103–104, 233, 235
  switches, 117, 253

Hard management, 53
Hard zoning, 49
Harris, Perry, 276
Health Insurance Privacy and Accountability Act (HIPAA), 279
Hewlett-Packard, 3
Hewlett-Packard/Compaq, DRM, 34
Hierarchical storage management (HSM), 71–72
High availability, 72–74
High-speed parallel SCSI, 22
Hitachi Data Systems, 3
  TrueCopy, 34
Host block aggregation, 16
Host bus adapters (HBAs), 18, 31–33, 54, 115–116
Host virtualization, 80
Hot sites, 321
HSM, 71–72
Hypertext Transfer Protocol (HTTP), 47

IBM, 2–3, 89–91, 146
  Global Services, 134, 177
  Tivoli for Storage, 67
IDE (Integrated Device Electronics), 17
IETF, 37
  Internet address, 30, 37
iFCP protocol, 38–40, 42, 51, 239
Improvement costs, minimizing, 207–209
Incremental backup, 145
Information technology goals, defining, 132
Information Technology (IT) business priorities, setting, 132
Infrastructure fluidity, 297
Innovation, 271
Insertion delay, 256

Integrated Cache-Based Disk Array, 91
Integrated network services, 185–186
  content delivery/capacity distribution, 186
  storage and networking services, 185–186
Intelligence systems, types of, 301
Intelligent credit spoofing, 254
Intelligent disk arrays, 14
Intelligent storage, 96–99
Interexchange carriers (IXCs), 244
Internal storage, 17
Internal Web sites, 167
Internet Fiber Channel Protocol (FCIP), 38, 42, 51, 239
Internet service providers (ISPs), 244
Internet Small Computer System Interface (iSCSI), *See* iSCSI
I/O interconnects, 203
IP, 30, 48, 123, 129–130
  networks, 123–124
IP core, making use of, 34
IP encryption (IPSec), 247
IP network, 28–29, 36
IP SAN protocols, 37–40
*IP SANs* (Clark), 26
IP storage:
  protocol options for, 37–38
  switches, 39, 62
  technologies, 102
IP storage data replication, technology behind, 255–258
IP storage fabric, 128–129, 246
  shared resource, flexibility of, 129
IP storage networking:
  and declassifying storage networking, 302–304
  and remote data replication, 254–255
  text overview, 8–10
  and IP NICs, 32
IP storage networks (IP SANs):
  defined, 13
  entry into a market, 13–14
  storage building blocks, 14–16
  scenarios, 211–216
    SAN extension, 213–214
    service provider SANs, 215–216
    storage consolidation, 214–215
  switches, 34
iSCSI, 22, 38–40, 318
  basics of, 28–29
  and block-oriented SCSI commands, 28
  HBAs, 247
  integrating with Fibre Channel across IP, 36–37
  with native IP interfaces, 36
  pure iSCSI storage networks, 29
  SANs, 29, 40
  using to interconnect Fibre Channel disk subsystems/Fibre Channel SANs, 37
IS-NIC, 127
ISP peering point, 244
IT deployment:
  effective migration, designing, 209–210
  improvement costs, minimizing, 207–209
  IT portfolio, creating/managing, 211, 294–296
  qualifying/quantifying, 207–211
  return on investment (ROI), calculating, 210–211
  total cost of ownership (TCO), calculating, 210–211
IT expenditures, 3
IT portfolio:
  creating/managing, 211, 294–296
  segmentation, 294–296
IT service recovery documentation, 322
IT service recovery model, 312
IT service recovery strategy, 307–332
  assets, identifying, 325
  backup strategy, 312–318
    automated off site backup, 313–314
    offsite tape backup storage, 313
    remote disk mirroring, 315–317
    split-site server array, 314–315
  communication mechanisms, 328–331
  distances, 328–331
  distributed systems strategy, 311–312
  documentation, 322
  executive overview, 307–309
    data destruction, 308
    distributed systems, dealing with, 307
    recovery facilities, investing in, 308–309
  protocols, 328–331
  recovery facility strategy, 318–321
    cold recovery site, 320
    contracted disaster recovery company, 321
    hot site, 321
    no recovery site, 319
    recovery partnerships, 319–320
  risks:
    assessment, 324–325
    asset importance to the business, 326–327
    identifying, 325–326

mitigating risks, 327
risk management, 327
SAN environment, evolution to, 310–311
speed, 327–332
strategic decisions, 311

Journaled file systems, 150
Juke box, 21
Just a bunch of disks (JBOD), 16, 17–18

Katz, Randy H., 19, 147
Key, 26

LAN-free backups, 68, 235
LANs, *See* Local area networks (LANs)
Last mile, use of term, 242
Layered protocols, 230–234
link layer, 230
network layer, 231
physical layer, 230
Legato Networker, 67
Linear tape-open (LTO), 21
Link layer, 230
Local area networks (LANs), 16, 21, 22, 128
Local exchange carriers (LECs), 244
Local loop bypass, 245
Local loop, use of term, 242
Logging file systems, 150
Logical volume management (LVM), 16
Logical volume manager layer, 163
Long-distance storage networking applications, 253–270
applications performance, estimating the effects of network latency on, 263–267
IP storage data replication, technology behind, 255–258
IP storage networking, and remote data replication, 254–255
sizing the link bandwidth for, 258–263
LTO (Hewlett-Packard), 146

Magnetic-optic (MO) drives, 21
Mainframes, 89
Maintenance, 6
Manageability, 87
Managed context, 275
Management, 6
Management Information Base (MIB), 47
Management simplicity:
defining, 275–276
incrementing to, 271–272
outsourcing for, 287–288
MANs, *See* Metropolitan area networks (MANs)
Mean time between failures (MTBF), 18, 139
Measuring returns on technology investments, 130–135
cost savings with storage area networks, 130–132
information technology goals, defining, 132
storage networking, as competitive advantage, 133–135
technology capabilities, tying with business processes, 133
Media access control (MAC) layer, 247
Metcalfe, Bob, 90
Metropolitan area networks (MANs), 34, 64, 128, 229, 234–239
asynchronous mirroring, 259
products, 239–242
services, 242–245
Microsoft Word, 193
Minicomputers, 90–91
Mirrored disks, 148
Mirroring, 72–74, 146–147, 253–254
Monitoring, 50–51, 60
MTBF, 18, 139
Moore's law, 102
Multilayered storage fabrics, 129–130
framework for, 129
Multivendor configurations, balancing, 105–106
Multivendor virtualization game, understanding, 79
Muxes, 230

NAS, *See* Network-attached storage (NAS)
NAS server, 15
NCP (NetWare), 317
Network, 203
centralization, 122–124
consolidation, 229
control points, 103–105
power/intelligence residing in, 3–4
storage deployments, 229
Network connectivity:
assessing, 229–252
layered protocols, 230–234
link layer, 230
network layer, 231
physical layer, 230
MAN and WAN products, 239–242

Network (*cont.*)
MAN and WAN services, 242–245
metropolitan area networks (MANs), 234–239
storage security, 246–249
areas of, 246–249
firewalls, 247
media access control (MAC) layer, 247
wide area networks (WANs), 234–239
Network File System (NFS), 57, 153, 317
Network interface cards (NICs), 31–33
Network layer, 231
Network-attached storage (NAS), 13, 15–16, 22–26, 302
basic architecture, 25
file services for, 56–57
filers, 57
NAS head, 57
and SAN, 23–26
Network-based storage services, 94–95
New IT service recovery model, 312
New storage capacity, 6
Node delay, 256
Normalized infrastructure gap, closing, 176

Offensive strategies, 120–130
common IP network vs. common technology, 128–129
equipment choice, providing, 121–122
meeting unforeseen demand, 121
multilayered storage fabrics, 129–130
network centralization, 122–124
platform consolidation, 124–128
storage agility, 121–122
Offsite media vaulting and recovery, 155–157
Offsite storage management, 182–183
Offsite tape backup storage, 313
Olsen, Ken, 90
On-line transaction processing (OLTP), 5, 65
Onsite storage management, 183–184
Operational agility, 4, 5–6, 171–200
application deployment, 194–196
corporate asset management, 196
integrated network services, 185–186
outsourced storage, 172–184
planning for, 6
service-level agreements (SLAs), managing, 186–194
Operational efficiency:
email storage case study, 219–221
fixed-content storage networking, 217–218
imaging fixed content, 221–222
maximizing, 216–224
ten-thousand-dollar terabyte, achieving, 222–224
Optical storage, 21–22
Optimized storage deployment, 4
Oracle Parallel Server, 153
Out-of-band virtualization, 78
Outsourced storage, 172–184
complete outsourcing, 177–178
considerations for, 288
core service offerings, 178–181
backup and restore, 179
content delivery, 181
primary storage area network, 178
primary network-attached storage, 178–179
remote network-attached storage, 180
remote storage area network, 180
remote tape backup and restore, 180
normalized infrastructure gap, closing, 176
offsite storage management, 182–183
onsite storage management, 183–184
outsourcing-related cost/opportunities, 288
storage service providers (SSPs), 174
capabilities of, 174–176
terabyte rental, 181–182
Oversubscription, 244

Packet-over-SONET routers, 232–233
Parallel backup streams, 156
Patterson, David A., 19, 147
PCI-Express, 203
PCI-X, 203
Peak hours, 259–260
Performance, 88
Performance impact, 144
Periodic replication, 159–160
Physical layer, 230
Placing storage intelligence, 96–101
attribute-based storage:
locations for storage services, 100
managing, 99–100
intelligent storage, 96–99
Platform consolidation, 124–128
Plug-Compatible Market (PCM), 90
Point-in-time and snapshot copy, 70–71
Point-in-time data images, 152
Policies systems:
business management policies, 283–285
creating, 282–287
risk-management policies, 285–286

Portfolio segmentation, 294–296
Power Point (Microsoft), 193
Practice disciplines, 277–278
Primary computing functions, 101
Process documentation, and service-level agreements (SLAs), 188–189
Processing delay, 256, 263
Products, MANs/WANs, 239–242
Propagation delay, 256, 264
Protocol conversion, 51–53
Protocols, 328–331

Quality of service for SANs, 64–65
  departmental segmentation/accounting, 66
  storage paths, 65–66
Quality of service policies, 59
Queuing delay, 256, 264
Quick recovery file systems, 150
Quota management, 60–61
Quota management policies, 59

RAID, *See* Redundant array of independent disks (RAID)
Rapid response model, 196
Real Application Clusters (RAC), 153
Reciprocal recovery agreements, 320
Recoverability, 88
Recovery facilities, investing in, 308–309
Recovery facility strategy, 318–321
  cold recovery site, 320
  contracted disaster recovery company, 321
  hot sites, 321
  no recovery site, 319
  recovery partnerships, 319–320
REDI SAN Links (XIOtech), 34
Redundant array of independent disks (RAID), 16, 17–19, 91, 147-150
  RAID array, 60–61, 149
  RAID levels, 19–20, 64, 148–149
Regulatory compliance, 280
Reliability, availability, and serviceability (RAS), 176
Remote backup and restore, 180
Remote data replication, 253
  and IP storage networking, 254–255
Remote disk mirroring configuration, 316
Remote mirroring and failover, 157–158
Remote network-attached storage (NAS), 180
Remote storage area network, 180
Replication, 72–74, *See also* Data replication
Replication technologies, stack layers for, 160–161
Resource efficiency, 55
Return on investment (ROI), 5–6
  calculating, 210–211
Returns on technology investments:
  measuring, 130–135
    cost savings with storage area networks, 130–132
    information technology goals, defining, 132
    storage networking, as competitive advantage, 133–135
    technology capabilities, tying with business processes, 133
Riser conduit, 243
Risk management, 279–281
  backup and restore, 280
  business continuity, 280
  disaster recovery, 280
  regulatory compliance, 280
  security, 280–281
Risk-management policies, 285–286
  disaster recovery scenarios, 286
  government and industry-related regulatory agencies, 286
  personnel and management, 285–286
  security, 286
  site/physical environment, 285
Risks, 114–115
  assessment, 325
  asset importance to the business, 326–327
  identification of, 325–327
  mitigating, 327
  managing, 327
ROI, *See* Return on investment (ROI)
Routers, 54

Scalability, 17, 92–93, 132, 144–145
Scalable routers, building, 93–94
SCSI (Small Computer System Interface), 16, 17–19, 22, 28–30, 120
  command set, 26
SDH (Synchronous Digital Hierarchy), defined, 230
  transmission rates, 236–237
Seagate, 146
Securities and Exchange Commission (SEC), 279, 281
Security, 88, 144, 280–281
  and risk management, 280–281
  and storage policy management, 61–62

Security policies, 59
Segmentation, 294–296
Server HBAs, 95
Server-based storage, 17
Server-free backups, 68–69
Serverless backups, 235
Service-level agreements (SLAs), 244, 279
  centralization, 191–192
  certification, 189–190
  discipline and business objectives, 187–188
  managing, 186–194
  normalizing management software, 193–194
  process documentation, 188–189
  standardization, 190–191
Services, MANs/WANs, 242–245
Shark (IBM), 3
Simple Network Management Protocol (SNMP), 47–48, 300
Simplified training, 6
Single-mode fiber-optic cable, 255
SMB/CIFS, 317
Snapshot copies, 70–71, 151–152
SNIA IP Storage Forum, 37
SNIA shared storage model, 14–15, 23
  benefit of, 15
Soft zoning, 49
Software, 37, 43–84
  data coordination, 56–58
    file services for NAS, 56–57
    storage aggregation, 58
    volume management, 57–58
  data protection, 66–72
    disk backup and recovery, 69–70
    hierarchical storage management (HSM), 71–72
    point-in-time and snapshot copy, 70–71
    tape-based backup, 67–69
  high availability, 72–74
  mirroring, 72–74
  quality of service for SANs, 64–65
    departmental segmentation/accounting, 66
    storage paths, 65–66
  replication, 72–74
  storage management software, 44–46
    core components of software management, 45
    need for, 44
    piecing together, 46
    user view of components, 44–46
  storage network management, 46–53
    discovery, 47–48
    hard and soft zoning, 49
    hard management, 53
    monitoring, 50–51
    protocol conversion, 51–53
    SAN topologies, 49–50
    zoning/configuration, 48–49
  storage policy management, 59–66
    authentication, 61–62
    capacity/content/quota management, 60–61
    security, 61–62
    storage encryption, 62–64
    storage policy cycle, 59–60
  storage resource management (SRM), 53–55
    capacity planning, 55
    device management, 54
    integration with other storage management applications, 55
    resource efficiency, 55
    subsystem management, 54–55
  virtualization, 74–79
    areas of deployment, 77–79
    basic concept, 75–76
    multivendor virtualization game, understanding, 79
    separating from data coordination and protection functions, 76–77
Software management:
  core components of, 45
  software elements of, 45
Solid-state storage, 21–22
  media, 21–22
SONET (Synchronous Optical Network), 34, 230–232
  defined, 230
  multiplexer networks, 231–232
  transmission rates, 236–238
Specialized storage equipment, retention of, 206–207
Speed, 327–332
Split-server site configuration, 315
Split-site server array, 314–315
SRDF (EMC), 34
SRM, *See* Storage resource management (SRM)
Standardization, service-level agreements (SLAs), 190–191
Storage:
  building blocks, 14–16
  client-server computing, 91–92
  distributed web/application/database servers, 92

future of, 299–304
application-specific storage, 299–300
automation, 300–301
new platforms, 301–302
storage networking, declassifying, 302–304
history/evolution of, 89–96
infrastructure investment in, 5–6
mainframe era, 89
minicomputers and clustering, 90–91
network-based storage services, 94–95
scalability, 92–93
scalable routers, building, 93–94
storage services, network choices for, 95–96
utilization rate, 3
in a wired world, 1–11
Storage administration, scope of, 296
Storage administrators, 51, 66
and subsystem management, 54–55
Storage aggregation, 58
Storage agility, 121–122
Storage area networks (SANs), 13, 15, 21, 26–37
cost savings with, 130–132
deployments, documenting, 53
Ethernet/IP, compared to Fiber Channel fabrics, 30–31
Fibre Channel, linking to Fibre Channel with IP, 34–36
Fibre Channel SANs, enhancing with IP, 33–34
history/background, 26–28
host bus adapters (HBAs), 31–33
IP core, making use of, 34
IP SAN protocols, 37–40
iSCSI, integrating with Fibre Channel across IP, 36–37
management applications, 50–51
management traps, 51
and NAS, 23–26
network interface cards (NICs), 31–33
performance metrics, 51
pure IP storage networks, 28–30
SAN environment, evolution to, 310–311
SAN topologies, 49–50
switches, 116
topology view of, 49–50
Storage array layer, 163–164
Storage category metrics, 3 02
Storage classification, 274
Storage degradation, 58
Storage devices, managed communication between, 48
Storage domain management, 271–292
context, 272
core:
context vs., 272–275
defined, 272
management simplicity:
defining, 275–276
incrementing to, 271–272
outsourcing for, 287–288
plan of attack, 276–282
business management, 278–279
data management, 281–282
practice disciplines, 277–278
risk management, 279–281
policies systems:
business management policies, 283–285
creating, 282–287
data management policies, 286–287
risk-management policies, 285–286
shaping, 282
storage infrastructure, as competitive differentiator, 273–274
Storage encryption, 62–64
types of, 63
Storage engine:
perfecting, 293–305
strategic objectives, 294–296
creating offensive and defensive strategies, 294
segment strategies with portfolio management, 294–296
tactical goals, 297–299
adapting to infrastructure fluidity, 297
monitoring organizational structure and utility, 298–299
preparing for geographic integration and consolidation, 298
using distributed resources and intelligence, 297–298
Storage infrastructure, 85
as competitive differentiator, 273–274
Storage management, dividing into discipline areas, 278
Storage management software, 43, 44–46
core components of software management, 45
need for, 44
piecing together, 46
user view of components, 44–46
Storage network management, 46–53
capacity planning, 55

Storage network management (*cont.*)
device management, 54
discovery, 47–48
hard and soft zoning, 49
hard management, 53
integration with other storage management applications, 55
monitoring, 50–51
protocol conversion, 51–53
resource efficiency, 55
SAN topologies, 49–50
storage resource management (SRM), 53–55
subsystem management, 54–55
zoning/configuration, 48–49
Storage networking:
as competitive advantage, 133–135
storage networking roadmap, charting, 6–7
zone configuration, 48
Storage Networking Industry Association (SNIA), 47
Storage networks:
measuring returns on technology investments, 130–135
cost savings with storage area networks, 130–132
information technology goals, defining, 132
storage networking, as competitive advantage, 133–135
technology capabilities, tying with business processes, 133
offensive/defensive strategies, balancing, 112–115
primary defensive strategies, 115–120
availability/protection with remote SAN topologies, 117–118
budget reduction and human capital protection, 118–120
data availability, 115–117
data availability and remote site storage user diagram, 118
primary offensive strategies, 120–130
common IP network vs. common technology, 128–129
equipment choice, providing, 121–122
meeting unforeseen demand, 121
multilayered storage fabrics, 129–130
network centralization, 122–124
platform consolidation, 124–128
storage agility, 121–122
reaping value from, 111–137
risk, 114–115
total cost of ownership (TCO), 114–115
Storage paths, 65–66
Storage policy cycle, 59–60
Storage policy management, 59–66
authentication, 61–62
capacity/content/quota management, 60–61
security, 61–62
storage encryption, 62–64
storage policy cycle, 59–60
Storage pools, 2
Storage redundancy layers, using, 168
Storage resource management (SRM), 53–55, 59
capacity planning, 55
device management, 54
integration with other storage management applications, 55
resource efficiency, 55
subsystem management, 54–55
Storage security, 246–249
areas of, 246–249
firewalls, 247
media access control (MAC) layer, 247
threats/solutions, 61
Storage service:
definitions, 87–88
deliverables, 85, 86–88
network choices for, 95–96
Storage service providers (SSPs), 174, 279
capabilities of, 174–176
Storage services:
network choices for, 95–96
optimal locations for, 100–101
Storage system control points, 85–110
distributed systems, building blocks of, 101–103
multivendor configurations, balancing, 105
network control points, 103–105
placing storage intelligence, 96–101
storage service:
definitions, 87–88
deliverables, 86–88
Storage technologies, 277
Storage transport quality of service, 65
Store-and-forward delay, 256
Strategic decisions, IT service recovery strategy, 311
Street cabinet, 243

Subsystem:
  management, 54–55
  virtualization, 80
Sun Microsystems, 3
Super DLT (Quantum), 146
Supply chain, 167
Switches, 54
Synchronous mirroring, 258–259
Synchronous replication, 73–74

Tape density, 19
Tape drives and tape libraries, 19–21, 90
Tape libraries, 68
Tape replenishment, 21
Tape-based backup, 67–69
Target audience, 7–8
TCP (Transmission Control Protocol), 233
TCP/IP, 31–32, 258, 266–267
Technology capabilities, tying with business processes, 133
Telecommunications vault, 243
Temporary recovery facilities, 319
Terabyte rental, 181–182
3DES encryption, 63, 246
Time windows, 259
Token Ring, 230
Topology managers, 50
Total cost of ownership (TCO), 114–115, 144
  calculating, 210–211
Total network latency estimate, 265
Transitioning between systems, 194–195
Traps, 51
TrueCopy (Hitachi), 34

Underground telecommunications vault, 243
Utilization, 3

Vendor viability, 144
Veritas File System (VxFS), 77
Veritas NetBackup, 67
Veritas Volume Manger (VxVM), 77
Virtual LANs (VLANs), 62, 65, 128
Virtual private networks (VPNs), 244–245
Virtualization, 46, 74–79
  areas of deployment, 77–79
  basic concept, 75–76
  fabric, 78–80
  host, 80
  multivendor virtualization game, understanding, 79
  out-of-band, 78
  physical placement of, 46
  separating from data coordination and protection functions, 76–77
  and storage aggregation capabilities of file services/volume management, 58
  subsystem, 80
Volume management, 57–58
  software, 157
Volumes, 14–16

WANs, *See* Wide area networks (WANs)
Wave division multiplexers (muxes), 230
Web-based Enterprise Management (WBEM), 47
Webster, John, 276
Wide area networks (WANs), 34, 64, 128, 229, 234–239, 259
  products, 239–242
  services, 242–245
Windows Driver Model (WDM), 237
Worldwide name (WWN), 49
Worldwide Unique Identifier (WWUI), 49
Write-complete acknowledgment, 236

XIOtech, REDI SAN Links, 34
XML, 47

Zoning/configuration, 48–49, 54