INDEX

Numerics

24-bit port addresses, 145
568SC connectors, 273
7200 Series Internet routers, 101
7600 Series routers, 102
8B/10B encoding, 273
8B/10B encoding method, 62

A

AAL-5 (ATM Adaptation Layer-5), 72
access
  data access, 44–46
  multiple storage devices, restricting, 184
  physical access, controlling, 180
  storage, troubleshooting, 199–200
active components, fiber-optic cabling, 111
active GBICs, 109
active hubs, 11
adapters, 42
addresses
  24-bit port addresses, 145
  IP addressing, 6
  iSCSI, 225–227
  loops, 135–136
  MAC (Media Access Control), 6
  ports, 69
  well-known addresses, 135
ADIC Fibre Channel technology, 269
administration policies, implementing, 183–184
Advanced Research Project Agency Network (ARPANET), 3
algorithms
  fairness algorithms, 165
  spanning-tree algorithm, 145
AL-PA (Arbitrated Loop-Physical Address), 273
AmDahl Corporation, Fibre Channel technology, 269
American National Standards Institute (ANSI), 30, 273
AMc Fibre Channel technology, 269
analogs signals, OSI, 5
analyzing vulnerabilities, 185
ANSI (American National Standards Institute), 30, 273
application layer (OSI), 8
application layer (iSCSI), 221
applications, monitoring, SAN management tools, 206
arbitration state, loops, 133
ARPANET (Advanced Research Project Agency Network), 3
asset tracking, SAN management tools, 206
ATM Products, Fibre Channel technology, 269
ATM (Asynchronous Transfer Mode), 273
ATM Adaptation Layer-5 (AAL-5). See AAL-5 (ATM Adaptation Layer-5)
Atto Technology, Fibre Channel technology, 269
automated backup and restoration model, 211
Avid Technology, Fibre Channel technology, 269
AVVID (Architecture for Voice, Video, and Integrated Data), 273
B

B2B transactions (Business-to-Business transactions), 273
B2C transactions (Business-to-Consumer transactions), 273
back reflectance, fiber-optic cabling, 117
backbones, networks, 14
backups
  backup window (total time), 210
  designing, 165
  disaster management, 207–211
  excessive network traffic, 19
  SAN model, 210–211
  sizing and planning, SAN management tools, 205
  traditional models, 207–209
BakBone’s SmartClient, 43
bandwidth, managing, 205
BER (Bit Error Rate), 274
best practices, SANs, 172–175
billing, SAN management tools, 206
block-level parity, RAID Level 4, 266
BNC-connectors, 9
BoxHill Systems Corporation, Fibre Channel technology, 269
bridges, 12, 13, 42, 274
choosing, 168
Fibre Channel, 100
bridging Fibre Channel to iSCSI, 224
broadcast servers, 147
Brocade Communications System, Fibre Channel technology, 269
brouters, 13–14, 274
building
networks, common devices, 9–14
SANs, 170–172
best practices, 173–175
bus and tag interface, 40
bus topology, 14, 274
business environments, securing, 192–193
business requirements, SANs, 154–155
byte synchronization, Fibre Channel, 64–65
byte-level parity, RAID Level 3, 265
cables, 41
cabling, Fibre Channel, 107
copper-based cabling, 107–111
fiber-optic cabling, 111–124
caches, write-back caches, 267
camp on feature, classes of service, Fibre Channel, 74
cascaded fabric topology, Fibre Channel, 56
cascaded loops, 140
Catalyst 4000 Family switches, 97–98
Catalyst 6000 Family switches, 96–97
CDs (compact discs), 274
libraries, 20
storage, 20
Central Patching Location (CPL), 122
centralized pooling, storage, 156–157
channels, 40, 49, 101, 274
Chaparral Technologies, Fibre Channel technology, 269
character conversion, Fibre Channel, 62
CIDs (connection IDs), 228
Ciprico, Fibre Channel technology, 269
Cisco 7200 Series Internet routers, 101
Cisco 7600 Series routers, 102
Cisco SN 5420 Storage routers, 101
cladding fiber-optic cabling, 111
classes of service, Fibre Channel
Class 1 service, Fibre Channel, 73–74
Class 2 service, Fibre Channel, 74–75
Class 3 service, Fibre Channel, 75
Class 4 service, Fibre Channel, 76
Class 5 service, Fibre Channel, 77
Class 6 service, Fibre Channel, 77
clients, simultaneous data access, inconsistencies, 19
close loop state, 135
collisions, 274
code violation checks, Fibre Channel, 64
coding rules, Fibre Channel, 62
command numbering (iSCSI), 230
Common Services layer, Fibre Channel, 71
communications, OSI (Open System Interconnect) reference model, 4–9
application layer, 8
data-link layer, 6
network layer, 6–7
physical layer, 4–5
presentation layer, 8
session layer, 8
transport layer, 7
Compaq Computer Corporation, Fibre Channel technology, 269
components
SANs, choosing, 170
securing, 186–191
configuration, fiber-optic cabling, 112
congestion prevention, designing, 165
connection IDs (CIDs), 228
connection-oriented data deliveries, 7
Connection Termination Phase (iSCSI), 230
connectionless data deliveries, 7
connections
daisy chains, 91
networks, common devices, 9–14
out-band connections, 189
physical connections, troubleshooting, 198–199
point-to-point connections, extending, 128
connectivity, SANs, 162
connectors, 41
568SC connectors, 273
DB-9 connectors, 108
fiber-optic connectors, 115–116
Fibre Channel, 84
GBICs (Gigabit Interface Converters), 85–86
GLMs (Gigabaud Link Modules), 86–87
MIAs (Media Interface Adapters), 90
transceivers, 88–89
media connectors, 280
contentions, 274
Media Access Control standards, 17
context switching, HBAs, 82
controllers (storage), support, 45
copper-based cabling, 41
  Fibre Channel, 107–111
copy-back caches, 267
cores, fiber-optic cabling, 111
CoS (class of service), 274
cost management, SAN management tools, 206
cost considerations, 19
CPL (Central Patching Location), 122
CRCs (Cyclic Redundancy Checks), 274
  Fibre Channel, 64
Crossroads System, Fibre Channel technology, 269
cut-through switching mechanisms, 145
dafs (Direct Access File System), 255–258, 275
  InfiniBand architecture, 258
  VI architecture, 257–258
daisy chains, connections, 91
dAS (direct attached storage), 22, 275
dASD (direct access storage device), 275
data access, 44–46
data alignment, Fibre Channel, 64–65
data availability, SANs, 158–162
data backups. See backups
data copy, sharing, 45
data exchange, iSCSI, 225–226
Data field (iSCSI packets), 222
data management, 204
data numbering (iSCSI), 230
data phase, SSCI, 218
data recovery, excessive network traffic, 19
Data Reference Number (DataRN), 230
data sharing, 45
data striping, RAID Level 0, 262
data transfer protocol, Fibre Channel, 66
data transfers, iSCSI, 228–230
data-link layer (OSI), 6
DataRN (Data Reference Number), 230
DB-9 media connectors, 108
DB-15 media connectors, 9
DB-25 media connectors, 9
DC (direct current), 65, 275
dedicated port speed, managed hubs, 93
dedicated simplex feature, CoS, Fibre Channel, 74
Dell Computer Corporation, Fibre Channel technology, 269
dense wavelength-division multiplexing (DWDM) 240, 246, 275
departmental fabric approach, 169
designing SANs, 153–170
  backups, 165
  best practices, 172
  business requirements, 154–155
  components, 170
  congestion prevention, 165
  connectivity, 162
  data availability, 158–162
  fault resilience, 164
  fault tolerance, 164
  future storage requirements, 162
  heterogeneity, 162
  manageability, 164
  migration, 163
  performance considerations, 155
  physical layout, 155
  restores, 165
  routability, 165
  scalability, 163
  security, 166
  storage pooling, 156–158
  storage system placement, 156
  topologies, 167–170
Destination Address field (iSCSI packets), 221
devices, 37–46
  bridges, 12–13
  routers, 13–14
  hubs, 11
  interconnection devices, 41–43
  media connectors, 9
  modems, 12
  NAS devices, 26–28
  networks, common devices, 9–14
  NICs (network identification cards), 10
  repeaters, 11
  routers, 13
  SANs, 28–31
  storage devices, 20–25
diagnostic capabilities, managed hubs, 94
digital signals, OSI, 5
directors, 275
  See also switches
  ESCON, 41
  FICON, 41
disabling Web browser management interface, 181
disk arrays, 21, 102, 275
disk mirroring, 275
disk pooling, 275
disk storage systems, 20
disparity violation checks, Fibre Channel, 64
disparity violation error method, Fibre Channel, 64
distributed networks, cost considerations, 19
distributed pooling, storage, 156, 158
divisional security, implementing, 192
Dot Hill Systems Corporation, Fibre Channel technology, 269
dotted decimal notation, IP addressing, 7
DVDs (digital versatile discs), 275
  libraries, 20
  storage, 20
DWDM (dense wavelength-division multiplexing), 240, 246, 275
  multiplexer devices, 243

E

E_Port (expansion ports), 52, 276
Electro-Magnetic Interference (EMI), 109, 276
Electro-Static Discharge (ESD), 109
embedded storage, 22
EMC Corporation, Fibre Channel technology, 270
EMI (Electro-Magnetic Interference), 109, 276
Emulex Corporation, Fibre Channel technology, 270
encapsulation, 217
  iSCSI, 225–226
encasement, fiber-optic cabling, 112
encryption, PKI (Public Key Infrastructure), 189
end nodes, iSCSI-based networks, 222
end-to-end flow control, transport layer (OSI), 7
Enterprise Network Storage Manager, 44
enterprise security, implementing, 193
Enterprise Systems Connection (ESCON) interface, 40, 276
EOF (End Of Frame), 276
ERP (Enterprise Resource Planning), 276
error detection, Fibre Channel, 64
ESCON (Enterprise Systems Connection) interface, 40, 276
ESD (Electro-Static Discharge), 109
Eurologic, Fibre Channel technology, 270
event notification features, SAN management tools, 206
  events, monitoring, 205
Exabyte Corporation, Fibre Channel technology, 270
  exchanges, Fibre Channel, 70
  expansion ports (E_Port), 52, 276
  extenders, 42, 276

F

F_Ports (fabric ports), 52, 276
Fabric, 276
  securing, 186–188
Fabric Address Notification (FAN), 147
Fabric Login protocol, Fibre Channel, 66
Fabric Logins (FLOGIs), 136, 277
Fabric management, 201–203
fabric ports (F_Port), 52, 276
Fabric Shortest Path First (FSPF) protocol, 145
Fabric zoning, 166
Fabrics
  alternate Fabrics, 169
  traffic over, 169
  fairness algorithms, 165
FAN (Fabric Address Notification), 147
fault tolerance, SANs, 164
FC-0 layer, Fibre Channel, 60–61
FC-1 layer, Fibre Channel, 61–65
FC-2 layer, Fibre Channel, 65–70
FC-3 layer, Fibre Channel, 71
FC-4 layer, Fibre Channel, 71–72
FC-AL (Fibre Channel-Arbitrated Loop), 40, 52, 127, 276
  Fibre Channel, 55–56
  SANs, 128–141
  states, 131
  types, 130–136
FCC (Fibre Channel Community), 30
FCIA (Fibre Channel Industry Association), 30, 276
FCIP (Fibre Channel over Internet Protocol), 252–253, 277
FCP (Fibre Channel Protocol), 277
fiber-optic cabling, 41
  active components, 111
  cladding, 111
  configurations, 112
  cores, 111
  encasement, 112
  Fibre Channel, 111–124
    advantages, 119–120
    fiber-optic connectors, 115–116
    planning and implementing, 116–119
    types, 112–115, 121–124
  implementing, 182
  jumper cabling, 120
  multimode fiber-optic cables, 113–114
  security benefits, 182
single-mode fiber-optic cables, 114–115
structured cabling, 121–124
waveguides, 111
fiber-optic connectors, 115–116
Fibre Channel, 49–51, 246
   advantages, 50–51
   analyzers, 200
   byte synchronization, 64–65
cabling, 107
copper-based cabling, 107–111
fiber-optic cabling, 111–124
classes of service, 73–77
connectors, 84–90
   GBICs (Gigabit Interface Converters), 85–86
   GLMs (Gigabit Link Modules), 86–87
   MIAs (Media Interface Adapters), 90
   transceivers, 88–89
CRCs (Cyclic Redundancy Checks), 64
data alignment, 64–65
development of, 36
error detection, 64
exchanges, 70
HBAs (Host Bus Adapters), 81–84
   managed hubs, 92–94
   switched hubs, 94–95
   unmanaged hubs, 92
hunt groups, 71
iSCSI, bridging, 224
layers, 59–72, 277
   FC-0 layer, 60–61
   FC-1 layer, 61–65
   FC-2 layer, 65–70
   FC-3 layer, 71
   FC-4 layer, 71–72
links, maintenance, 65
multicasting, 71
ordered sects, 66
ports, 51–53
problems with, 215–216
products
   bridges, 100
   connectors, 84–90
   HBAs (Host Bus Adapters), 81–84
   hubs, 90–94
   routers, 100–102
   storage devices, 102–104
   switches, 94–98
   routers, 100–102
sequences, 70
storage devices, 102–104
disk arrays, 102
JBODs (Just a Bunch of Disks), 103
storage servers, 104
tape libraries, 103–104
striping service, 71
switches, 94–100
   Catalyst 4000 Family switches, 97–98
   Catalyst 6000 Family switches, 96
types, 95–96
topologies, 53–59
FC-AL topology, 128–141
point-to-point topology, 127–128
switched Fabric topology, 141–150
vendors, 269–271
Fibre Channel Community (FCC), 30
Fibre Channel Industry Association (FCIA), 30, 276
Fibre Channel Link Encapsulation (Fibre Channel-LE), 72
Fibre Channel-Arbitrated Loop (FC-AL). See FC-AL (Fibre Channel-Arbitrated Loop)
FICON (Fibre Connection) interface, 40, 277
Field Replacement Units (FRUs), 93
Finisar Corporation, Fibre Channel technology, 270
FL_Port (Fabric-Loop ports), 277
FLOGIs (Fabric Logins), 136, 277
formats, packets, iSCSI, 221–222
Frame Check Sequence (FCS) field (iSCSI packets), 222
frame delimiters, 65, 67
frames
   LISM (Loop Initialization Select Master), 132
   loop master, issuing, 133
Framing and signaling protocol layer (Fibre Channel), 65–70
FRUs (Field Replacement Units), 93
FSPF (Fabric Shortest Path First), 277
FSPF (Fabric Shortest Path First) protocol, 145
FTP (File Transfer Protocol), 277
Fujikura, Fibre Channel technology, 270
full-duplex dialogs, session layer (OSI), 8
full-duplex mode, 277
Full-Feature Phase (iSCSI), 229
G
Gadzoox Networks, Fibre Channel technology, 270
gateways, 43, 277
choosing, 168
294 GBICs (Gigabit Interface Converters)

GBICs (Gigabit Interface Converters), 85–86, 41, 277
active GBICs, 109
copper-based cabling, 108–110
intercabinet GBICs, 110
intracabinet GBICs, 110
transceivers, categorizations, 89
Gigabit Link Modules (GLMs), 41, 86–87, 277
gigabytes, 277
GLMs (Gigabit Link Modules), 41, 86–87, 277

H

hackers, 181
half-duplex mode, 278
half-duplex dialogs, session layer (OSI), 8
Hamming code, RAID Level 2, 264
hardware addresses, 6, 280
HBAs (Host Bus Adapters), 42, 81-84, 222, 278
context switching, 82
heterogeneity, SANs, 162
Hewlett Packard, Fibre Channel technology, 270
High Speed Connect (HSC), 82
HIPPI (High Performance Parallel Interface), 278
Hitachi Data Systems, Fibre Channel technology, 270
hops, number, choosing, 169
Host Bus Adapters (HBAs). See HBAs (Host Bus Adapters)
Hotmail, 18
hot-pluggable ports, managed hubs, 93
HSC (High Speed Connect), 82
HSSDC (High-Speed Serial Data Connector), 278
HTTP (Hypertext Transfer Protocol), 278
hubs, 11, 42, 278
active hubs, 11
choosing, 167
Fibre Channel, 90–92, 98–100
managed hubs, 92–94
switched hubs, 94
intelligent hubs, 11
network population, 99
services, 99
shared bandwidth, 98
switches, compared, 98–100
hunt groups, Fibre Channel, 71

I

I/O bandwidth, storage devices, inability to keep up, 19
I/O host buses, 82
IANA (Internet Assigned Numbers Authority), 69
IBM Corporation
  Fibre Channel technology, 270
  services, 44
IEEE 802.5, 72
IETF (Internet Engineering Task Force), 278
iSCSI, 216–218
IFCP (Internet Fibre Channel Protocol), 253–255, 278
implementation
  fiber-optic cabling, 116–119
  problems, recording, 171
  security, 178–180
in-band management, 201, 278
InfiniBand architecture, DAFS, 258
InfiniBand Trade Association (InfiniBandTA), 31, 278
InfiniBandTA (InfiniBand Trade Association), 31, 278
infrastructure, storage, 39
initialization state, loops, 132
installing, 222
intelligent hubs, 11
Intelligent Peripheral Interface (IPI), 72, 83
interactive parity, RAID Level 5, 267
intercabinet GBICs, 110, 279
interconnection devices, 41–43
interconnects, 279
interface cards, iSCSI, 222
interfaces, 40
intermix feature, classes of service, Fibre Channel, 74
Internet, 3
Internet Assigned Numbers Authority (IANA), 69
Inter-Switch Links (ISLs). See ISLs (Inter-Switch Links)
Intracabinet GBIC, 110, 279
in-transit data, securing, 183
IP (Internet Protocol) addresses, 6, 72
dotted decimal notation, 7
IP SANs, 243–245
IP field (iSCSI packets), 222
IP SANs, 247, 279
IP sniffing, 181
IP spoofing, 181
IPI (Intelligent Peripheral Interface), 72, 83
IPSec, 229
IPX (Internetwork Packet Exchange), 279
iSCSI (Internet Small Computer System Interface), 215
addressing schemes, 225–227
challenges, 236–237
components, 222–224
data exchange, 225–226
data transfers, 228–230
designing, 231–236
encapsulation, 225–226
Fibre Channel technology
bridging, 224
problems with, 215–216
IETF, 216–218
iSCSI-based networks, 222–224
naming schemes, 225–227
NICs (network interface cards), 222
numbering, 230–231
ordering, 230–231
packets, 221–222
PDUs (Protocol Data Units), 220
protocol stack, 220–221
SCSI, 218–219
security, 231–236
sessions, 228–230
iSCSI (Internet SCSI), 279
iSCSI initiators, 222
iSCSI layer (iSCSI), 221
ISDN (Integrated Services Digital Network), 279
ISLs (Inter-Switch Links), 159, 168, 279
isolating problems, 197–200
ISPs (Internet service providers)
choosing, 184
SLAs (Service-level Agreements), 185
storage providers, 245–247

J-L

Jaycor Networks, Fibre Channel technology, 270
JBOD (Just a Bunch Of Disks), 33, 103, 279
Fibre Channel, 103
jumper cabling, 279
fiber-optic cabling, 120

L_PORT (loop ports), 52, 280
layers
Fibre Channel, 59–72
OSI, 4
Legato Systems Inc., Fibre Channel technology, 270
Level 0 (RAID), 262–263
Level 1 (RAID), 263
Level 1 Setup (data availability), 159
Level 2 (RAID), 263–264
Level 2 Setup (data availability), 159
Level 3 (RAID), 264–265
Level 3 Setup (data availability), 160
Level 4 (RAID), 266–267
Level 4 Setup (data availability), 161
Level 5 (RAID), 267–268
levels, RAID, 268
 RAID Level 0, 262–263
 RAID Level 1, 263
 RAID Level 2, 263–264
 RAID Level 3, 264–265
 RAID Level 4, 266–267
 RAID Level 5, 267–268
libraries
CDs, 20
DVDs, 20
storage, 20
tape libraries, Fibre Channel, 103–104
tapes, 21–22
LILP (Loop Initialization Loop Position), 280
link layer (iSCSI), 220
links
maintaining, Fibre Channel, 65
switches, 159
LIPs (Loop Initialization Primitives), 132, 280
LIRP (Loop Initialization Report Position), 280
LISM (Loop Initialization Select Master) frames, 132, 280
load monitoring, SAN management tools, 206
local pooling, 156–157
Login phase (iSCSI), 228
logins
Fabric logins, 146
loops, 136–137
long-distance non-cascaded loops, 138
Loop Initialization Primitives (LIPs), 132, 280
Loop Initialization Select Master (LISM) frames, 132
loop masters, 133, 280
loop ports (L PORT), 52, 280
loops

- addressing, 135–136
- cascaded loops, 140
- FC-AL loops, types, 130–136
- logins, 136–137
- long-distance non-cascaded loops, 138
- protocols, 134
- short-distance non-cascaded loops, 138
- loose configuration, fiber-optic cabling, 112
- LSILogic, Fibre Channel technology, 270
- LU (logical unit), 280
- LUNs (Logical Unit Numbers), 280
- masking, 166, 280
- switched Fabric, 148

N

- N_Port (node ports), 52, 137, 282
- N_Port Login protocol, Fibre Channel, 66
- N_Port Logout protocol, Fibre Channel, 66
- namespaces, mountable namespaces, 45
- MTI Technology Corporation, Fibre Channel technology, 270
- multicasting, Fibre Channel, 71
- Multi-Mode Fiber (MMF) cables, 41
- multimode fiber-optic cables, 113–114
- multiple storage devices, access, restricting, 184
- multiplexors, 42
- Mylex, Fibre Channel technology, 270

M

- MAC (Media Access Control) addresses, 6, 280
- managed hubs
  - Fibre Channel, 92–94
  - FRUs (Field Replacement Units), 93
- Management console, 201
- management interface, managed hubs, 94
- management policies, implementing, 185
- masking, LUN masking, 166
- MCA (Micro Channel Architecture), 82
- Mcdata Corporation, Fibre Channel technology, 270
- Media Access Control (MAC) addresses, 6, 280
- Media Access Control standards, 17–18
- media connectors, 9, 280
- Media Interface Adapters (MIAs). See MIAs (Media Interface Adapters)
- megabytes, 280
- mesh topology, 15–16, 281
- Methode Electronics, Fibre Channel technology, 270
- MIAs (Media Interface Adapters), 41, 90, 281
  - copper-based cabling, 110–111
  - optical MIAs, availability, 90
- Micro Channel Architecture (MCA), 82
- migration, SANs, 163
- mirroring
  - disks, 275
  - RAID Level 1, 263
- MIS (Management Information System), 281
- MMF (multi-mode fiber), 281
- modems, 12, 281
- Molina, Joe, 261
- monitoring state, loops, 133
- mountable namespaces, 45
- NAT (Network Address Translation), 281
- NDMP (Network Data Management Protocol), 26, 250–251, 281
- network attached storage (NAS). See NAS (network attached storage)
- network communications, OSI (Open System Interconnect) reference model, 4–9
  - application layer, 8
  - data-link layer, 6
  - network layer, 6–7
  - physical layer, 4–5
  - presentation layer, 8
  - session layer, 8
  - transport layer, 7
- Network Data Management Protocol (NDMP), 26, 250–251
- NDMP (Network Data Management Protocol)
- network identification cards (NICs). See NICs (network identification cards)
- network layer (OSI), 6–7
- network population, 99
- network transport layer (iSCSI), 221
- networks
  - backbones, 14
  - building common devices, 9–14
  - connecting common devices, 9–14
OSN (open storage networking), 240–243, 282
out-band connections, 189
out-of-band management, 202, 282

packets, iSCSI, 221–222
partitions, space threshold, SAN management tools, 206
passwords, implementing, 181
PCI (Peripheral Component Interconnect) bus slots, 40, 82
PDU (Protocol Data Units), 220
performance considerations, SANs, 155
performance management, 205
performance monitoring, SAN management tools, 206
perimeter security, implementing, 182
Peripheral Component Interconnect (PCI), 40, 82
Peterson, Michael, 38
physical access, controlling, 180
physical connections, troubleshooting, 198–199
physical layer (OSI), 4–5
physical layer (Fibre Channel). See FC-0 layer
physical layout, SANs, 155
PKI (Public Key Infrastructure), 189
planning problems, recording, 171
plastic encasement, fiber-optic cabling, 112
PLOGIs (Port Logins), 136, 282
point-to-point connections, 40
  extending, 128
point-to-point topology, 282
  Fibre Channel, 54
  SANs, 127–141
policies
  administration policies, implementing, 183–184
  management policy, implementing, 185
  security, 180
polling, 282
polling intervals, automated, SAN management tools, 206
pooling, storage, 156–158
port addresses, 69
port levels, 282
Port logins (PLOGIs), 136, 282
ports
  Fibre Channels, 51–53
  levels, 282
positional maps, 132
practices, SANs, 172–175
Preamble field (iSCSI packets), 221
presentation layer (OSI), 8
primitive sequence protocol, Fibre Channel, 66
primitive sequences, receivers, 65
primitive signals, 67
Prisa Networks, Fibre Channel technology, 270
private loops (FC-AL), 130
PRLI (Process LogIn), 137, 282
Protocol Data Units (PDUs), 220
protocol stacks, iSCSI, 220–221
protocols, 3, 50, 283
loops, 134
NDMP (Network Data Management Protocol), 26
upper-level protocols, troubleshooting, 200
Public Key Infrastructure (PKI), 189
public loops (FC-AL), 131

Q-R

Qlogic, Fibre Channel technology, 271
QoS (quality of service), SAN management tools, 206
Quantum Corporation, Fibre Channel technology, 271
RAID (Redundant Array of Independent Disks), 21, 261–262, 283
history of, 261
levels, 268
RAID Level 0, 262–263
data striping, 262
RAID Level 1, 263
mirroring, 263
RAID Level 2, 263–264
Hamming code, 264
memory systems, 264
RAID Level 3, 264–265
byte-level parity, 265
RAID Level 4, 266–267
block-level parity, 266
RAID Level 5, 267–268
interactive parity, 267
RaidTec Corporation, Fibre Channel technology, 271
read requests, 266
Redundant Array of Independent Disks (RAID). See RAID (Redundant Array of Independent Disks)
Registered State Change Notification (RSCN), 147
remote management, disabling, 182
repeaters, 11, 283
requests
read requests, 266
small-read/write requests, 268
response phase, SCSI, 218
restoration
disaster management, 207–211
SAN model, 210–211
classical models, 207–209
restores, designing, 165
ring topology, 15–16, 283
RJ-45 media connectors, 9
routability, designing, 165
routers, 13, 43, 283
choosing, 167
Fibre Channel, 100–102
RSCN (Registered State Change Notification), 147, 283

S

SAN management tools, 205–207
SANs (storage area networks), 28, 33, 283
benefits of, 33–37
best practices, 172–175
building, 170–175
building blocks, 37–46
changes, need for, 239–240
components, 37–46
designing, 153–170
backups, 165
best practices, 172
business requirements, 154–155
components, 170
congestion prevention, 165
connectivity, 162
data availability, 158–162
fault resilience, 164
fault tolerance, 164
future storage requirements, 162
heterogeneity, 162
manageability, 164
migration, 163
performance considerations, 155
physical layout, 155
restores, 165
routability, 165
scalability, 163
security, 166
storage pooling, 156–158
storage system placement, 156
topologies, 167–170
development of, 240
devices, 37–46
evolution of, 33–37
interconnects, 41–43
interfaces, 40
IP SANs, 243–245
managing, 201–206
NAS, compared, 29, 231–236
servers, 39
software, 43
standard organizations, 29–31
storage, infrastructure, 39
topologies
FC-AL, 128–141
point-to-point topology, 127–141
switched Fabric topology, 141–150
SANworks Storage Resource Manager, 44
SBCCS (Single Byte Command Code Set), 72
scalability, SANs, 163
SCN (State Change Notification), 283
SCSI (Small Computer System Interface), 19, 218–219, 283
evolution of, 33–34
Fibre Channel, advantages, 50
limitations of, 34
limited scalability support, 19
SCSI command set layer (iSCSI), 221
SCSI Enclosure Services (SES), 201, 284
SCSI over IP networks. See iSCSI
SCSI Trade Association, 30
SCSI-3, 40
SCSITA (SCSI Trade Association), 283
Seagate Technology, Fibre Channel technology, 271
security
administration policies, implementing, 183–184
business environments, 192–193
components, 186–191
designing, 166
divisional security, implementing, 192
encryption, PKI (Public Key Infrastructure), 189
enterprise security, implementing, 193
Fabric, 186–188
fiber-optic cables
benefits, 182
implementing, 182
guidelines, 180–185
hackers, 181
hubs, 99
implementing, 178–180
in-transit data, 183
iSCSI, 231–236
management policies, 185
multiple storage device access, restricting, 184
passwords, implementing, 181
perimeter security, implementing, 182
policies, user account management directions, 180
remote management, disabling, 182
service providers, choosing, 184
software-based security, 191
storage systems, 190–191
switches, 99
vulnerabilities, analyzing, 180, 185
Web browser management interface, disabling, 181
Selective Storage Presentation (SSP), 188, 247, 284
sequences, Fibre Channel, 70
servers, 39
broadcast servers, 147
server farms, 34
storage, 35
Service-Level Agreements (SLAs). See SLAs (Service-Level Agreements)
service providers
choosing, 184
SLAs (Service-Level Agreements), 185
storage service providers, 245–247
SES (SCSI Enclosure Services), 201, 284
session IDs (SIDs), 228
session layer (OSI), 8
sessions, iSCSI, 228–230
shared bandwidth
hubs, 98
switches, 98
sharing data, 45
short-distance non-cascaded loops, 138
SIDs (session IDs), 228
simplex dialogs, session layer (OSI), 8
300 simultaneous data access, multiple clients, inconsistencies

- simultaneous data access, multiple clients, inconsistencies, 19
- Single Point of Failure (SPOF), 158
- single-mode fiber (SMF) cables, 41
- single-mode fiber-optic cables, 114–115
- Small Computer System Interface (SCSI). See SCSI (Small Computer System Interface)
- small-read/write requests, 268
- SmartClient, 43
- SMF (single-mode fiber), 284
- SN 5420 Storage routers, 101
- SNIA (Storage Networking Industry Association), 29, 284
- SNICs (Storage NICs), 222
- SNMP (Simple Network Management Protocol), 92, 284
- SNS (Simple Name Server), 284
- SOF (Start of Frame), 284
- software-based security, 191
- SoIP (Storage over IP), 247-249, 284
- Source Address field (iSCSI packets), 221
- spanning-tree algorithm, 145
- SPOF (Single Point of Failure), 158
- SRM (Storage Resource Management), 204
- SSPs (Selective Storage Presentations), 188, 247, 284
- stacked connect feature, classes of service, Fibre Channel, 74
- standard organizations, SANs, 29–31
- star topology, 15, 284
- states, FC-AL loops, 131
- status numbering (iSCSI), 230
- storage, 157
  - access, troubleshooting, 199–200
  - CDs, 20
  - DVDs, 20
  - embedded storage, 22
  - infrastructure, 39
  - libraries, 20
  - monitoring, SAN management tools, 206
  - servers, 35
  - service providers, 245–247
  - techniques, 20–25
- storage area networks (SANs). See SANs (storage area networks)
- storage controllers, support, 45
- storage devices, 20–25

- choosing, 168
- Fibre Channel, 102–104
- Storage Networking Industry Association (SNIA), 29, 284
- storage networks, necessity of, 18–20
- Storage NICs (SNICs), 222
- storage pooling, SANs, 156–158
- Storage Resource Management (SRM), 204
- storage servers, Fibre Channel, 104
- storage systems placement, 156
  - securing, 190–191
- StorageTek, Fibre Channel technology, 271
- StorNet Inc., Fibre Channel technology, 271
- Strategic Research Corporation, 38
- striping, RAID Level 0, 262
- striping service, Fibre Channel, 71
- structured cabling, 284
  - fiber-optic cabling, 121–124
  - CPL (Central Patching Location), 122
  - small-scale storage networks, 118
- subnets, 13, 284
- subsystems, tape subsystem, Fibre Channel, 21-22, 103–104
- Sun Microsystems, Fibre Channel technology, 271
- SWAN (storage wide-area network), 284
- switched Fabric topology, 284
  - Fibre Channels, 56–59
  - SANs, 141–150
- switched hubs, Fibre Channel, 94
- switched-based zoning, 187
- switches, 43, 58
  - choosing, 167
  - directors, 43
  - Fibre Channel, 94–96
  - Catalyst 4000 Family switches, 97–98
  - Catalyst 6000 Family switches, 96–97
  - Fibre Channels, 98–100
  - hubs, compared, 98–100
  - links, 159
  - network population, 99
  - services, 99
  - shared bandwidth, 98

- tape libraries, Fibre Channel, 103–104
- tape library, 285
- tape subsystems, Fibre Channel, 103–104
tapes
  libraries, 21–22
  subsystems, 21–22
TCO (Total Cost of Ownership), 158, 285
T-connectors, 9
TCP field (iSCSI packets), 222
TCP/IP (Transmission Control Protocol/Internet Protocol), 3
TDM (time-division multiplexing), 50
techniques, storage, 20–25
terabytes, 285
Text-Mode Negotiation Phase (iSCSI), 229
tight configurations, fiber optic cabling, 112
time-division multiplexing (TDM), 50
Tivoli Storage Network Manager, 43
token passing, Media Access Control standards, 17
tokens, 285
topologies, 285
  bus topology, 274
  choosing, 167–170
  Fibre Channels, 53–59
  networks, 14–17
  ring topology, 283
SANs
  FC-AL, 128–141
  point-to-point topology, 127–141
  switched fabric topology, 141–150
Total Cost of Ownership (TCO), 158, 285
traffic
  backups, 19
  data recovery, 19
  excessive, 19
  monitoring, SAN management tools, 206
transceivers
  connectors, Fibre Channel, 88–89
  GBICs, categorizations, 89
Transmission Control Protocol/Internet Protocol (TCP/IP), 3
Transmission Protocol layer (Fibre Channel). See FC-1 layer
transmission speeds, variance, 75
transmission words, 63
transport layer (OSI), 7
  error correction, 6
trend analysis, SAN management tools, 206
Troika Networks, Fibre Channel technology, 271
troubleshooting
  physical connections, 198–199
  problems, 197–200
  storage access, 199–200
  upper-level protocols, 200
  true data sharing, 46
  trunk cables, varieties, 121
  tunneling, 217
  Type field (iSCSI packets), 221
U
U.S. Department of Defense (DoD), 3
UDP (User Datagram Protocol), 285
UPLs (Upper-Level Protocols), 60
Upper-Layer Protocol Mapping layer (Fibre Channel). See FC-4 layer
Upper-Level Protocols (ULPs), 60
  upper-level protocols, troubleshooting, 200
V-Z
vendors
  Fibre Channel technology, 269–271
  SAN software, 44
  Veritas, Fibre Channel technology, 271
  VI (virtual interface), 285
  DAFS, 257–258
  Vicom Systems Inc., Fibre Channel technology, 271
  virtual SANlets, 187
  Vixel Corporation, Fibre Channel technology, 271
  VPNs (Virtual Private Networks), 285
  vunerability, analyzing, 180, 185
waveguides, fiber-optic cabling, 111
Web browser management interface, disabling, 181
Web-based mail services, 18
  well-known addresses, 135
  World Wide Port Name (WWPN), 132, 286
  World Wide Unique Identifier (WWUI), 226, 286
  write-back caches, 267
  WWN (World Wide Name), 285
  WWPN (World Wide Port Name), 132, 286
  WWUIs (World Wide Unique Identifiers), 226, 286
Yahoo! search engine, 18
zoning, 286
  Fabric zoning, 166
  managed hubs, 93
  switched Fabric, 148
  switched-based zoning, 187