

# Index

## A

- access control subsystems SNMPv3 engines, 48–49
- Accounting Server
  - aggregation, 211
  - basics, 208–210
  - correlation, 211
  - mediation, 210
  - reports, 212
- actions, 151–156
- AF (assured forwarding), PHBs, 162
- agents (SNMP), 11, 13, 36–37
- aggregate objects, 33–34. *See also* LSPs; VLANs; VPNs
- alarms, 35
- Alcatel, network management software, 28
- AS (autonomous system) network, 152
- ATM (Asynchronous Transfer Mode), 4
  - LANE, 19
  - linked overviews, 99–101
  - PNNI, 21
  - ports, 24
  - PVCs, 25–26
  - scalability on virtual circuits, 85–86
  - SPVCC, 20
  - VPI/VCI, 20, 23
- authentication
  - in different versions, 62
  - protocols, 52
  - Security Server, 218–219
  - SNMP message format, 49–51, 60–61

## B

- best effort QoS (quality of service), 117, 161
- Borland JBuilder, 107

## C

- Charlotte's Networks routers, stress testing, 90
- CIM (Common Information Model), 159–160
- Cisco network management software, 28
  - stress testing, 90
- CLI (command-line interface), 13
  - EMS compatibility, 30
  - Telnet, 32
- coarse granularity QoS (quality of service), 117–119
- COM (Component Object Model), 108
- command generator and responder SNMPv3 applications, 49
- Configuration Server
  - basics, 202–203
  - connection table updates, 204–205
  - creating network objects, 205
  - secure users, 203–204
  - server database tables, 206
  - software structure, 208
  - topology updates, 205–206
  - trace files, 204
- ContextID and ContextName objects (SNMP), 49, 51
- converged networks, 33–34
- COPS (Common Open Policy Service), 156–157
- CORBA specifications, OMG, 107–108
  - NMS middleware, 225
- CPE (customer premises equipment), SP networks, 24

cross-connects  
 LERs, 74  
 LSRs, 74  
 MPLS, 111, 113, 263–264  
 CTI (computer-telephone integration), 7

## D

DEFVAL MIB object attribute, 40  
 DEN (Directory-Enabled Networking), 158–160  
 DES (Data Encryption Standard) keys, 49, 60  
 DESCRIPTION MIB object attribute, 40  
 DiffServ (Differentiated Services) QoS, 24, 117–119, 161  
   attacks, 165  
   MPLS, 164–165  
 discovery, 34–35  
   and mapping (NNM), 172–173  
 Discovery Server, 220  
 dispatchers, SNMPv3 engines, 48–49  
 DMI (Desktop Management Interface), 32, 33

## E

EF (expedited forwarding), PHBs, 162  
 EGP (Exterior Gateway Protocol), 102  
 EMS (element management systems), 13  
   management system value pyramid, 28–31  
   Telnet, 32  
   VLANs, 9  
 encryption, SNMPv3, 52, 53, 60  
 EngineBoots objects (SNMP), 49, 51  
 EngineID objects (SNMP), 49, 51  
 EngineTime objects (SNMP), 49, 51  
 enterprise networks  
   categories of networks, 1  
   components, 4–5  
   data flows, 6  
   deployment  
     centralized, 6–7  
     geographically distributed, 5  
   disadvantages, 9  
   features, 7  
   intranets, 6  
   lifecycles, 7  
   migration toward IP networks, 69–70  
   scalability issues, 89  
   services provided, 2–3  
   storage planning, 8  
   unified messaging, 6  
 entities (SNMP). *See* agents (SNMP)  
 EROs (Explicit Route Objects), 111–112

Ethernet ports, 24  
 events, 35

## F

Fault Server  
   basics, 197–200  
   database tables, 200–201  
   software structure, 201  
   topology updates, 201–202  
 faults, 35  
 FCAPS areas, OSI model, 26–28, 78  
 FTN MIB, 299–300  
 NMS stovepipes, 140–141  
 software layers, 95  
 fine granularity QoS (quality of service), 117–118  
 Foundry Networks routers, stress testing, 90  
 FTN (FEC-To-NHLFE MIB)  
   basics, 292–295  
   example, 295–296  
   mplsFTNTable setup, for LSP redirection, 296–298  
   mplsFTNTable setup, for tunnel redirection, 298

## G

GET operations  
   JDMK sample program, 248  
   Visual C++ sample program, 240  
 GetBulkRequest messages (SNMP), 44, 56–57, 62  
 GETNEXT operations  
   JDMK sample program, 248–249  
   Visual C++ sample program, 240  
 GetNextRequest messages (SNMP), 44, 55–56, 62  
 GetRequest messages (SNMP), 44, 54–55, 60  
 GetResponse messages (SNMP), 44, 86

## H

Hewlett-Packard OpenView, 10, 28  
 NNM  
   backup and restore, 179  
   basics, 168–169  
   data warehousing, 178  
   discovery and mapping, 172–173  
   integration with other software, 187  
   Java-based Web interface, 180–181  
   mediation, 170–171  
   MIBs, 183  
   monitoring, 174  
   MPLS support, 183  
   notification processing, 176  
   policy support, 184  
   programmability, 187–188

Hewlett-Packard OpenView  
 NNM (*continued*)  
 reliability, 185  
 reporting, 177  
 host routing tables, 154

**I**

IDL (Interface Definition Language), 31  
 management software, 108  
 IGP (Interior Gateway Protocol), 102  
 IIOP (Internet Inter-Orb Protocol), 107–108  
 in-segments  
 LERs, 74  
 LSRs, 74  
 MPLS, 111, 113, 261  
 InetAddressType MIB object, 41  
 information models  
 CIM, 159–160  
 DEN, 158–160  
 InformRequest messages (SNMP), 44, 57–60  
 interfaces (IP networks), 101  
 interfaces *versus* ports, 24–25  
 IntServ (Integrated Services) QoS, 117–118, 161  
 IP networks  
 layer 3, OSI model, 21–22  
 linked overviews, 101–102  
 managed objects, 101–102  
 migration toward IP networks, 69–70  
 MPLS routing protocols, 114  
 QoS levels, 160–164  
 routing table controls, 151–155  
 SLAs, 160–161  
 ipInReceives object, 39  
 IS-IS (Intermediate System–Intermediate System) routing protocol, 73  
 IP protocols, 102  
 MPLS, 114  
 traffic engineering, 116

**J–K**

Java RMI (Remote Method Invocation), 108  
 JBuilder (Borland), 107  
 JDMK (Java Development Management Kit) sample program  
 extensions, 251–253  
 GET operations, 248  
 GETNEXT operations, 248–249  
 SNMP manager, 245–247  
 SNMP manager, synchronous, 249

*versus* Visual C++ SNMP sample program,  
 249–251

Juniper routers, stress testing, 90

**L**

label operations (MPLS), 114–115  
 encapsulation, 115–116  
 LANE (ATM LAN Emulation), 19  
 LANs (large area networks), 3  
 layer 2, OSI model, 17–21  
 VPNs  
 scalability, 83–85  
 layer 2.5, OSI model, 22–23  
 layer 3, OSI model, 21–22  
 VPN scalability, 85  
 LEAP (Lightweight Flow Accounting Protocol), 299  
 LERs (label edge routers)  
 MIB scalability, 87–89  
 MPLS nodes, 71–75  
 stress testing networks, 90  
 lexicographic ordering, MIBs, 43  
 LSPs (label switched paths), 20, 21  
 MIB scalability, 87–89  
 MPLS  
 components, 111–113  
 DiffServ support, 164–165  
 service-level network components, 300  
 stress testing networks, 90  
 LSRs (label switching routers)  
 MIB scalability, 87–88  
 MPLS nodes, 71–75  
 stress testing networks, 90

**M**

MacAddress object, 39  
 managers (SNMP), 36, 37–39  
 MAX-ACCESS MIB object attribute, 40, 41  
 MaxMessageSize objects (SNMP), 49–50, 54  
 MD5 protocol, SNMP privacy settings, 49, 52, 60–61  
 message subsystems SNMPv3 engines, 48–49  
 MessageFlags objects (SNMP), 49–51, 53–55  
 MessageID objects (SNMP), 49–50, 54  
 MessageSecurity objects (SNMP), 49, 51, 54  
 MessageVersion objects (SNMP), 49–50, 54  
 MIBs (Management Information Bases), 2  
 basics, 143, 288  
 centralizing to match NE features, 146  
 columns  
 default values, 291–292  
 tightly coupled intercolumn dependencies,  
 289–290

- component of SNMP, 36, 39–40
  - Configuration Server support, 206–207
  - extensions, 66
  - FTN MIB
    - basics, 292–295
    - example, 295–296
    - mplsFTNTable setup, for LSP redirection, 296–298
    - mplsFTNTable setup, for tunnel redirection, 298
  - lexicographic ordering, 43
  - manipulating with scripts and software modules, 10–11
  - necessary for management, 10–12
  - NMS support features, 181–182
  - objects
    - attributes, 40–42
    - default values, 144–145
    - management, 11–12, 66, 182
    - semantic dependencies, 144
  - OIDs, 42–43
  - quality, 15–16
  - scalability, 86, 87–89, 291–292
    - scalable aggregated services, 175
  - sections, 64–65
  - versus* standard operating systems, 66–67
  - textual conventions, 39
  - thin software layers, 291–292
  - upgrades following MIB changes, 105–106
  - WALK operations, 241–242
  - Microsoft SMS (Systems Management Server), 6, 16, 32
  - Monitoring Server, 220–221
  - MPLS (Multiprotocol Label Switching) networks, 1–2
    - basics, 68–71
    - creating LSPs, 88
    - cross-connects, 111, 113, 263–264
    - deploying on NEs, 256–257
    - DiffServ, 164–165
    - EROs, 111–112
    - example, 258–261
    - in-segments, 111, 113, 261
    - interfaces, 257–258
    - label operations (MPLS), 114–115
      - encapsulation, 115–116
    - label stacks, 264–265
    - layer 2.5, OSI model, 22–23
    - LERs, 71–75
    - LSPs, 20, 21, 111–113
      - configuring through LSRs, 266–267
      - creating with LSR MIB, 267–273
      - examples, 258–266
        - standards, 284
        - and tunnels, 283
    - main components, 110–111
    - MIBs, 255–256
      - FTN MIB, 292–299
      - nextObjectIndex counter, 283–284
      - standards, 284
    - migration to IP networks, 69–70
    - nodes, 71
    - out-segments, 111, 113, 262–263
    - protocols, routing and signaling, 114
    - QoS, 116–119
    - resource blocks, 111–112
    - scalability, 119–122
    - traffic engineering, 116, 117, 119–122, 265
    - tunnel table objects, 120–122
      - mplsTunnelHopTable, 282
      - mplsTunnelResourceTable, 278–279
      - mplsTunnelResourceTable, configuring, 281–282
      - mplsTunnelTable, 273–278
      - mplsTunnelTable, configuring, 280–281
    - tunnels, 111–113, 119–122
      - creating, 283
      - standards, 284
  - mplsFTNAddrType MIB object, attributes, 40–42
  - mplsFTNTable object
    - setup for LSP redirection, 296–298
    - setup for tunnel redirection, 298
  - mplsInSegmentTable object, 261
  - mplsInterfaceConfTable object, 259–261
  - mplsInterfacePerfTable object, 266
  - mplsLabelStackTable object, 264–265
  - mplsOuSegmentTable object, 262–263
  - mplsTunnelHopTable object, 282
  - mplsTunnelIncludeAffinity object, 145
  - mplsTunnelIndexNext object, 87, 147
  - mplsTunnelResourceTable object, 278–279
    - configuring, 281–282
  - mplsTunnelTable object, 273–278
    - configuring, 280–281
  - multiservice switches, 138
    - operational skill set requirements, 110
    - testing, 90
- N**
- NBI (Northbound Interface), 226
    - integration with OSS layers, 304–305
  - NEs (network elements)
    - advantages and disadvantages, 90–91
    - basics, 67–68, 148–149

- NEs (network elements) *(continued)*
  - CLI compatibility, 30
  - configuring, 223–225
  - database backup and restore, 222–223
  - feature of enterprise networks, 7
  - manageability, 15–16
  - managing newly commissioned and legacy NEs, 11
  - shrink-wrapped solutions, 303–304
  - software distribution, 221–222
- nextObjectIndex object, 87, 283–284
- NICs (network interface cards), 7
- NMS (network management systems), 1–2
  - Accounting Server
    - aggregation, 211
    - basics, 208–210
    - correlation, 211
    - mediation, 210
    - reports, 212
  - advantages, 16–17
  - basics, 10–14
    - components, 230–231
  - boundaries, 191
  - business processes, 188–189
  - Configuration Server
    - basics, 202–203
    - connection table updates, 204–205
    - creating network objects, 205
    - MIB support, 206–207
    - secure users, 203–204
    - server database tables, 206
    - software structure, 208
    - topology updates, 205–206
    - trace files, 204
  - data and code combinations, 81–83
  - data model, 146–147
    - distributed clients and servers, 147–148
  - data warehousing, 177–178
  - database backup and restore, 178–179
    - and upgrade, 223
  - discovery, 34–35, 171–172
  - Discovery Server, 220
  - Fault Server
    - basics, 197–200
    - database tables, 200–201
    - software structure, 201
    - topology updates, 201–202
  - goals, 35
  - integration with other software, 185–187
  - Java
    - RMI, 179–180
    - trends towards Java-based NMS, 226–227
  - management system value pyramid, 28–32
    - EMS, 28–31
    - OSS, 28–29, 31–32
  - mapping, 171–172
  - MIBs, 181–182
  - middleware, 225
  - migration toward IP networks, 69–70
  - monitoring, 173–174
    - Monitoring Server, 220–221
  - MPLS support, 183
  - NBI, 226
  - notifications, 35
    - processing, 176
    - SNMPv3, 57–60
  - object creating using software abstraction, 301–302
  - operational skill set requirements, 108–110
  - OSI model
    - FCAPS areas, 26–28
    - layer 2, 17–21
    - layer 2.5, 22–23
    - layer 3, 21–22
  - Performance Server
    - aggregation, 213–214
    - basics, 212–213
    - correlation, 214
    - database tables, 216
    - reports, 214–215
    - SLA alerts, 215–216
    - topology updates, 216
  - policy-based (PBNM), 149–150
    - architectural elements, 150–151
    - COPS, 156–157
    - network processors, 157–158
    - policies, 155–156
  - policy support, 184
  - ports *versus* interfaces, 24–25
  - programmability, 187
  - reasons for using, 25–26
  - reliability, 184–185
  - reporting, 176–177
  - requirements for high-level support, 136–137
  - security, end-to-end, 302–303
  - Security Server
    - access applications, 217–218
    - basics, 217
    - permitted views, 219
    - privilege levels, 219
  - services management, 137–139
  - shrink-wrapped solutions, 303–304
  - software components, 193–197

- software development
    - basics, 103–104
    - class design, 107
    - CORBA-based, 107–108
    - data analysis, 104–105
    - deployment software, 135
    - GUIs, 107
    - insulating applications from low-level code, 108
    - object-oriented development, 106–107
    - UML, 106–107
    - upgrades following MIB changes, 105–106
  - software development skill sets
    - basics, 91–93
    - cross-functional cooperation, 133–136
    - distributed creative problem solving, 95–96
    - domain expertise, 97–98
    - linked overviews, ATM view, 99–101
    - linked overviews, basics, 98–99
    - minimal code changes, 103
    - short development cycles, 102–103
    - solution engineering, 125–129, 306–307
    - solution engineering, example, 131–133
    - solution engineering, expertise in general-purpose software, 129–130
    - solution engineering, thinking in chunks, 130–131
    - solution mindset, taking ownership, 96–97
  - software vendors, 28
  - stovepipe structure, 139–143
  - uses, 189–190
  - VLANs, 9
  - workflows, 188–189
  - XML data representation, 225
  - NNM (Network Node Manager) Hewlett-Packard
    - OpenView
      - backup and restore, 179
      - data warehousing, 178
      - discovery and mapping, 172–173
      - integration with other software, 187
      - Java-based Web interface, 180–181
      - MIBs, 183
      - monitoring, 174
      - MPLS support, 183
      - notification processing, 176
      - policy support, 184
      - programmability, 187–188
      - reliability, 185
      - reporting, 177
  - nodes (IP networks), 101
    - cross-connects, 111, 113
    - in-segments and out-segments, 111, 113
  - Nortel network management software, 28
  - notifications, 35
    - notification originator and receiver SNMPv3 applications, 49
    - processing, 176
    - SNMPv3, 57–60
- O**
- object attributes, MIBs, 40–42
  - OBJECT IDENTIFIER MIB object attribute, 40
  - object-oriented software development, 106–107
  - OIDs (object identifiers), MIBs, 42–43
  - OMG (Object Management Group)
    - CORBA specifications, 107–108
    - IDL, 108
  - OpenView (Hewlett-Packard), 10, 28. *See also* NNM
  - OSI model
    - FCAPS areas, 26–28, 78
      - FTN MIB, 299–300
      - NMS stovepipes, 140–141
      - software layers, 95
    - layer 2, 17–21
      - VPN scalability, 83–85
    - layer 2.5, 22–23
    - layer 3, 21–22
      - VPN scalability, 85
    - network management standards, 35
  - OSPF (Open Shortest Path First) routing protocol, 73
    - IP protocols, 102
    - MPLS, 114
      - traffic engineering, 116
  - OSS (Operational Support System)
    - integration with NBI, 304–305
    - management system value pyramid, 28–29, 31–32
    - and NBI, 226
  - out-segments
    - LSRs, 74
    - MPLS, 111, 113, 262–263
- P**
- PBNM (policy based network management), 149–150
    - architectural elements, 150–151
    - components, triggers and actions, 151–156
    - COPS, 156–157
    - network processors, 157–158
    - policies, 155–156
  - PDPs (policy server/decision points), 150, 156–157
  - PDUs (protocol data units), 43–44
    - inform fields, 59–60
    - trap fields, 58–59

- PEPs (policy enforcement points), 150, 156
  - PHB (per-hop-behavior), 118, 161–162, 164
  - PIBs (Policy Information Bases), 157
  - PNNI (Private Network-to-Network Interface), 21
  - ports *versus* interfaces, 24–25
  - privacy settings, SNMP message format, 49–51
  - protocols (IP networks), 102
  - proxy forwarder SNMPv3 applications, 49
  - PSTNs (Public Switched Telephone Networks), 5
  - PVCs (permanent virtual circuits)
    - ATM, 25–26
- Q**
- QA (quality assurance), role in network management, 305
  - QoS (quality of service)
    - interface level, 24
    - IP networks, 160–164
    - MPLS, 116–119
- R**
- RMI (Remote Method Invocation), 108
  - Routing Policy Specification Language, 153
  - RowStatus object, 39
  - RPCs (remote procedure calls), 82
    - management software development, 108
- S**
- SANs (storage area networks), 5
    - feature of enterprise networks, 7
    - incompatible management systems, 10
    - lifecycle stages, 8
  - scalability
    - ATM virtual circuits, 85–86
    - MIBs, 86, 87–89, 291–292
    - MPLS, 119–122
    - VPNs
      - layer 2, OSI model, 83–85
      - layer 3, OSI model, 85
  - Security Server
    - access applications, 217–218
    - authentication, 218–219
    - permitted views, 219
    - privilege levels, 219
  - security subsystems SNMPv3 engines, 48–49
  - serial link-based menu systems, 32, 33
  - SET operations, Visual C++ sample program, 241
  - SetRequest messages (SNMP), 44, 57
  - SHA (Secure Hash Algorithm) protocol, 49, 52, 60–61
  - SLA (service level agreements), 17, 21
    - alerts for Performance Server, 215–216
    - QoS, 160–161
- SMI (Structure of Management Information)
    - SPPI, 157
    - version 2, 39
  - SMS (Systems Management Server), Microsoft, 6, 16, 32
  - SNMP manager
    - JDMK sample program, 245–247
      - synchronous manager, 249
    - Visual C++ sample program, 233–236
  - SNMP (Simple Network Management Protocol), 1
    - agents, 11, 13, 36–37
    - applications
      - MIB browsers, 62–66
      - types, 49
    - configuring Windows NT/2000 platform, 231
    - de facto standard for network management, 35–36
    - disadvantages of using SNMP, 14–15
    - manageability of NEs, 15–16
    - managers, 11, 36, 37–39
    - message exchanges
      - basics, 53
      - GetBulkRequest, 44, 56–57
      - GetNextRequest, 44, 55–56
      - GetRequest, 44, 54–55
      - GetResponse, 44
      - InformRequest, 44, 57–60
      - SetRequest, 44, 57
      - Trap, 44, 57–60
    - message format
      - common data, 49–51
      - context, 49, 52–53
      - PDUs, 49, 53
      - PDUs, inform fields, 59–60
      - PDUs, trap fields, 58–59
      - security model data, authentication, 49–52, 60–62
      - security model data, general, 49, 51
      - security model data, privacy, 49–52, 60–61
  - MIBs, 36, 39–40
    - lexicographic ordering, 43
    - manipulating with scripts and software modules, 10–11
    - necessary for management, 10–12
    - object attributes, 40–42
    - object management, 11–12
    - OIDs, 42–43
    - quality, 15–16
    - versus* Microsoft SMS, 32
  - NMS discovery, 34–35
  - PDUs, 43–44

- problems, 61
  - sample program, JDMK
    - extensions, 251–253
    - GET operations, 248
    - GETNEXT operations, 248–249
    - SNMP manager, 245–247
    - SNMP manager, synchronous, 249
  - sample program, Visual C++, 236–238
    - batch files, combining, 243
    - extensions, 251–253
    - GET operations, 240
    - GETNEXT operations, 240
    - versus* JDMK, 249–251
    - MIB WALK operations, 241–242
    - Security violations, 243–245
    - SET operations, 241
    - setup, 231–232
    - SNMP manager, 233–236
    - TRAP operations, 242–243
  - SNMPv3 engine, 48–49
  - SNMPv3 security *versus* view-based access controls, 53
  - versions, 44, 61–62
  - SOAP (Simple Object Access Protocol), 225
  - SP (service provider) networks
    - categories of networks, 1
    - CPE, 24
    - migration toward IP networks, 69–70
    - reasons for using management, 25–26
  - SPPI (Structure of Policy Provisioning Information), 157
  - SPVCC (Switched Permanent Virtual Channel Connection), 20
  - STATUS MIB object attribute, 40
  - storage. *See also* SANs
    - enterprise network planning, 8
  - StorageType object, 39
  - subnets (IP networks), 101
  - SYNTAX MIB object attribute, 40, 41
- T**
- TCP/IP. *See* IP networks
  - TDM (time-division multiplexing), 20
  - Telelogic CM Synergy, 136
  - Telnet, 32
  - TestAndIncr object, 39
  - textual conventions, MIBs, 39
  - thin software layers
    - MIBs, 291–292
    - software solutions, 306
  - TLS (Transparent LAN Service), 132
- TOM (Telecommunications Operations Map), 31
  - traffic engineering, MPLS, 116, 117, 119–122
  - Trap messages (SNMP), 44, 57–60, 86
  - TRAP operations, Visual C++ sample program, 242–243
  - triggers, 151–155
  - TruthValue object, 39
  - tunnels, MPLS, 111–113, 119–122
- U**
- UML (Uniform Modeling Language), 106–107
  - UNIX platform, network management software, 28
  - UserName objects (SNMP), 49, 51
- V**
- VCI (Virtual Channel Identifiers), 20, 23
  - versions of SNMP, 44
  - Visual C++ sample program, 236–238
    - batch files, combining, 243
    - extensions, 251–253
    - GET operations, 240
    - GETNEXT operations, 240
    - versus* JDMK, 249–251
    - MIB WALK operations, 241–242
    - security violations, 243–245
    - SET operations, 241
    - setup, 231–232
    - SNMP manager, 233–236
    - TRAP operations, 242–243
  - VLANs (virtual LANs), 3, 8–9
    - aggregate objects, 33–34
    - feature of enterprise technology, 8–9
    - layer 2, OSI model, 17–21
    - multisite example, using SP ATM/MPLS cloud, 131–133
    - NMS discovery, 34
    - service-level network components, 300
  - VoIP (voice over IP), 3
  - VPI (Virtual Path Identifiers), 20, 23
  - VPLS (Virtual Private LAN Service), 131–133
  - VPNs (virtual private networks)
    - OSI layer 2 and 3 scalability, 83–85
    - service-level network components, 300
- W–Z**
- WALK operations, MIBs, 42, 241–242
  - WANs (wide area networks)
    - MPLS, 1
    - VoIP, 3
  - Web Services, 225
  - Windows NT/2000, network management software, 28
  - XML data representation, 225