

# Index

---

## Numerics

- 5-4-3 rule, 81
- 10 Gigabit Ethernet, physical media specifications, 79
- 10-Mbps Ethernet, network design rules, 74
- 100-BASE-FX Fast Ethernet, network design rules, 75
- 100-BASE-T Fast Ethernet, network design rules, 75
- 100-BASE-T4 Fast Ethernet, network design rules, 75
- 100-BASE-TX Fast Ethernet, network design rules, 75
- 100-Mbps Fast Ethernet, network design rules, 74
- 1000BASE-CX Gigabit Ethernet, network design rules, 78
- 1000BASE-LX Gigabit Ethernet, network design rules, 77
- 1000BASE-SX Gigabit Ethernet, network design rules, 78
- 1000BASE-T Gigabit Ethernet, network design rules, 78

## A

- ABRs (area border routers), 362
- access control, 446
- access layer of hierarchical LAN architecture, 39–40
  - best practices, 86–87
- access point modes (LWAPP), 122–123
- access VPNs, 188
- ACD, 511
- Acknowledgment packet (EIGRP), 339

## address allocation

- IPv6, 265
  - global unicast addresses*, 267
  - IPv4-compatible addresses*, 267
  - link-local addresses*, 267
  - loopback addresses*, 266
  - multicast addresses*, 268–269
  - site-local addresses*, 268
  - unspecified addresses*, 266

reserving subnets for VoIP devices, 239

## address assignment methods for IPv6, 273

### address classes (IPv4), 228–229

- class A addresses, 230
- class B addresses, 230
- class C addresses, 230
- class D addresses, 230
- class E addresses, 231

## address representation of IPv6, 262–263

### addressing

- IPv4
  - NAT*, 232
  - private addresses*, 231
  - subnetting*, 233–241

### IPv6

- address allocation*, 265–269
- compatibility with IPv4*, 263
- name resolution*, 272

### adjacencies, 359–360

### administrative distance, 299, 396

### advanced distance-vector protocols, EIGRP, 334

- DUAL, 336–337
- IPv6 support, 341–342
- metrics, 337–339
- neighbor discovery and recovery, 335–336
- packets, 339
- protocol-dependent modules, 335

- 
- RTP, 336  
timers, 337
- AFI field (RIP messages),** 322, 326
- AfriNIC (African Network Information Centre),** 229
- aggregation layer,** 94
- aggregator attribute (BGP),** 400
- anycast addresses, IPv6,** 265
- APNIC (Asia Pacific Network Information Center),** 229
- application layer**  
    OSI model, 623  
    SONA, 10–11  
    TCP/IP protocol, 625
- areas**  
    IS-IS, 374  
    OSPF, 360  
        *NSSAs*, 365  
        *stub areas*, 364  
        *totally stubby areas*, 365  
        *virtual links*, 366  
    OSPFv3, 368
- ARIN (American Registry of Internet Numbers),** 229, 391
- ARP (Address Resolution Protocol),** 53  
    IPv4 address assignment, 244–245
- AS external LSAs,** 364
- AS external paths,** 364
- AS path attribute (BGP),** 398
- ASA (Adaptive Security Appliance),** 468
- ASBRs (autonomous system border routers),** 362
- AS-External LSAs (OSPFv3),** 370
- ASN.1 (Abstract Syntax Notation 1),** 550
- atomic aggregate attribute (BGP),** 399–400
- attributes (BGP),** 396
- authentication**  
    IS-IS, 375  
    RIPng, 328  
    RIPv2, 325
- autonomous systems, BGP confederations,** 395–396
- AutoQoS,** 532–533
- Auto-RP,** 414
- availability, increasing,** 56
- B**
- backbone routers,** 362
- backup options for WANs,** 190–191
- bandwidth,** 301  
    on VoIP networks, 527–528  
    WAN technology considerations, 169
- BDRs (backup designated routers),** 362–363
- Beauty Things scenario,** 577–579
- Bellman-Ford algorithm,** 295
- best path selection**  
    BGP, 401  
    metrics, 300–301  
        *bandwidth*, 301  
        *cost*, 302–303  
        *delay*, 303  
        *hop count*, 301  
        *load*, 303  
        *MTU*, 304  
        *reliability*, 304
- BGP (Border Gateway Protocol),** 390  
    administrative distance, 396  
    attributes, 396  
        *aggregator*, 400  
        *AS path*, 398  
        *atomic aggregate*, 399–400  
        *community*, 399  
        *local preference*, 397

*MED*, 398–399  
*next-hop*, 397  
*origin*, 398  
*weight*, 400  
best path selection, 401  
confederations, 395–396  
eBGP, 391  
iBGP, 392  
    *route reflectors*, 393–395  
    *uses of*, 393  
IPv6 support, 274  
neighbors, 391  
transit autonomous systems, 392  
**BHT (busy hour traffic)**, 512  
**Big Oil and Gas scenario**, 574–576  
**binary numeric system**, 630  
    converting to decimal, 632  
    converting to hexadecimal, 631  
bits, 630  
**blocking probability**, 512  
**BOOTP**, 242  
**Branch of One**, 207  
**BRI**, 158, 506  
**BRI (Basic Rate Interface)**, 157  
**Bridge mode (LWAPP)**, 123  
bridges, 82  
    wireless, 165  
**broadband cable WANs**, 163  
**broadcast storms**, 57  
**busy hour**, 512

## C

**cable WANs**, 163  
**calculating**  
    BHT, 512  
    EIGRP metric, 338  
    Erlangs, 511  
    IGRP metric, 331  
    serialization delay, 529  
**campus LANs**, 85, 90  
    edge distribution module, 91  
    multicast considerations, 96  
        *CGMP*, 97  
        *IGMP snooping*, 97  
    QoS considerations, 95–96  
**campus networks**  
    security, implementing, 482

**CAS (channel associated signaling)**, 506  
**Catalyst 6500 services modules**  
    security, integrating, 481–482  
**CBT (Core-Based Trees)**, 412  
**CBWFQ (Class-Based Weighted Fair Queuing)**, 171  
**CCS (Centum Call Second)**, 512  
**CCS (Common Channel Signaling)**, 506  
**CDP (Cisco Discovery Protocol)**, 307, 555–556  
**CDRs (call detail records)**, 512  
**CE (customer edge) routers**, 161  
**cell-switched WANs**, 185  
**Centrex services**, 510  
**certificates**, 446  
**CGMP (Cisco Group Management Protocol)**, 97, 411  
**channel aggregation**, 58  
**channelized T1**, 503  
**characterizing networks**  
    network analysis tools, 20  
    network audit tools, 17–20  
    network checklist, 20–21  
**CIDR (classless interdomain routing)**, 240, 390  
**circuit-switched WANs**, 185  
**Cisco ASDM (Adaptive Security Device Manager)**, 478  
**Cisco Catalyst switches**, 468  
**Cisco Enterprise Architecture**, 42–44  
    Enterprise Campus Module, 43  
    Enterprise Edge Module, 45  
        *E-Commerce submodule*, 45  
        *Internet Edge submodule*, 46–47  
        *VPN/Remote Access submodule*, 47–48  
    Enterprise WAN Module, 48–49  
    Remote modules, 50  
        *Enterprise Branch module*, 50  
        *Enterprise Data Center module*, 51  
        *Enterprise Teleworker module*, 51  
    SP Edge Module, 49  
**Cisco Enterprise Branch Architecture**, 200  
**Cisco Enterprise MAN/WAN**, 193–195  
**Cisco Identity-Based Network Services as Cisco Self-Defending Network technology**, 472  
**Cisco IOS Software**, 197  
    available packages, comparing, 198  
    security, integrating, 478

- Cisco IPS (intrusion prevention system),** integrating security, 480–481
- Cisco ISR (Integrated Services Routers),** integrating security, 479
- Cisco RRM (Radio Resource management),** 132
- Cisco Secure Connectivity System,** 447
- Cisco Security Appliances,** integrating security, 480
- Cisco Security MARS (Monitoring, Analysis, and Response System),** 477
- Cisco Self-Defending Networks,** 467
  - network phases, 469
  - secure connectivity, 446
  - Threat Defense, 450
  - trust and identity technologies, 470
    - Cisco Identity-Based Network Services,* 472
    - firewalls,* 470
    - NAC,* 471
  - underlying security platforms, 468
- Cisco UWN (Unified Wireless Network),** 119
  - branch design considerations, 137
    - hybrid REAP,* 137
    - local MAC,* 137
    - REAP,* 137
  - campus design considerations, 136–137
  - LWAPP, 121
    - access point modes,* 122–123
    - controller components,* 125
      - AP controller equipment scaling, 127
      - intracontroller roaming,* 127
      - Layer 2 intercontroller roaming,* 128
      - Layer 3 discovery,* 123
      - Layer 3 intercontroller roaming,* 128
      - mobility groups,* 130
      - WLAN authentication,* 124–125
  - radio management, 132
    - RF groups,* 133
  - RF site surveys, 133
  - wireless mesh, 134–135
- Class I repeaters,** 76
- Class II repeaters,** 76
- Class A addresses,** 230
- Class B addresses,** 230
- Class C addresses,** 230
- Class D addresses,** 230
- Class E addresses,** 231
- classful routing protocols,** 298
- classless routing protocols,** 298
- clusters (BGP),** 393, 395
- CME deployment model (IPT),** 520
- CMTS (Cable Modem Termination System),** 163
- codecs**
  - analog-to-digital signal conversion, 520
  - standards, 521
- codepoints,** 226
- collision domains (100BASE-T), maximum size of,** 76
- Command field**
  - RIP messages, 322
  - RIPng messages, 329
  - RIPv2 messages, 326
- commands**
  - ip subnet-zero,* 235
  - show interface,* 304
  - show ip protocol,* 323
  - show ip rip database,* 321
  - show version,* 18–20
  - switchport host,* 87
- community attribute (BGP),** 399
- companding,** 521
- comparing**
  - Cisco IOS Software packages, 198
  - IPv6 and IPv4, 277
  - NetFlow and RMON, 555
  - routing protocols
    - classless versus classful,* 298
    - flat versus hierarchical,* 297
    - IPv4 versus IPv6,* 299
    - link-state versus distance-vector,* 297
    - static and dynamic routes, 292
    - WANs, 156–157
- compatibility of IPv6 addresses with IPv4,** 263
- components**
  - of IPT, 516
  - of security policies, 440
- compression,** 170
- confederations,** 395–396
- confidentiality**
  - breaches in, 436–437
  - transmission confidentiality, 449

**configuring**  
 IS-IS, NET, 373  
 redistributed route metrics, 406

**connectivity, 446**  
 dialup, 157

**control, 440**

**converting**  
 binary to decimal, 632  
 binary to hexadecimal, 631  
 decimal to binary, 633–634  
 decimal to hexadecimal, 627  
 hexadecimal to decimal, 629–630

**core layer of hierarchical LAN architecture, 38**  
 best practices, 88

**cost metric, 302–303, 359**

**counting to infinity, 306, 322**

**country codes, 509**  
 NANP, 509

**CQ (Custom Queuing), 171**

**creating security policies, 438**

**CRPT, 530**

**CSA (Cisco Security Agent), integrating security, 482**

**CS-ACS (Cisco Secure Access Control Server), 477**

**CSA MC (CSA Management Center), 477**

**CSM (Cisco Security Manager), 477**

**customer requirements, identifying, 15–16**

**cut-through switching, 83**

## D

**dark fiber, 166**

**DARPA (Defense Advanced Research Projects Agency), 624**

**data compression, 170**

**data integrity, 449**

**data link layer (OSI model), 621**

**database services, 510**

**data-center module, 92**  
 server connectivity options, 93

**datagrams, 222**

**DC aggregation layer, 94**

**DE (Discard Eligibility) bit, 159**

**decimal numeric system**  
 converting to binary, 633–634  
 converting to hexadecimal, 627

**delay components on VoIP networks, 528–530**

**delay metric, 303**

**delay-start signaling, 505**

**dense multicast routing, 412**

**deployment models**  
 for IPT  
*CME deployment model, 520*  
*multisite centralized WAN call-processing deployment model, 519*  
*multisite distributed WAN call-processing deployment model, 519*  
*single-site deployment model, 518*

for IPv6  
*dual-stack backbones IPv6 deployment model, 276–277*  
*IPv6 over dedicated WAN links, 275*  
*IPv6 over IPv4 tunnels, 276*  
*protocol translation mechanisms, 277*

**design document, 23**

**design phase of PDIOO, 14**  
 top-down design process, 21–22

**deterministic redundancy, 130**

**devices**  
 bridges, 82  
 Catalyst 6500 service modules, integrating security, 481–482  
 Cisco IOS routers and switches, integrating security, 478  
 Cisco IPS, integrating security, 480–481  
 Cisco ISR, integrating security, 479  
 Cisco Security Appliances, integrating security, 480  
 CSA, integrating security, 482  
 hubs, 82  
 Layer 3 switches, 85  
 repeaters, 81  
 routers, 84–85  
 switches, 83–84

**DHCP, 522**  
 IPv4 address assignment, 242–243

**DHCPv6, IPv6 address assignment, 273**

**dialup technology, 157**

**diameter, 38**

**digital signaling, 503, 506**

**digital signatures, 449**

**discretionary well-known attributes, 396**  
 atomic aggregate, 399–400  
 local preference, 397

**distance-vector routing protocols**, 295  
 EIGRP, 296  
 IGRP, 330  
*metrics*, 331–333  
*network design*, 333  
*timers*, 331  
 loop prevention schemes, 305  
 RIPv1, 320  
*counting to infinity*, 322  
*flush timer*, 323  
*forwarding information base*, 321  
*holddown timer*, 323  
*invalid timer*, 323  
*message format*, 321  
*network design*, 323  
*update timer*, 322  
 RIPv2, 324  
*authentication*, 325  
*forwarding information base*, 325  
*message format*, 326–327  
*network design*, 327  
*timers*, 327  
 versus link-state routing protocols, 297

**distribution layer of hierarchical LAN architecture**, 38–39  
 best practices, 87–88

**distribution trees**, 412

**DLCI (data-link connection identifier)**, 159

**DNS**, 522  
 IPv4 address assignment, 243  
 IPv6 implementations, 272

**DOCSIS (Data Over Cable Service Interface Specifications)**, 163

**Domains of Trust**, 443–444

**DoS attacks**, 435  
 preventing, 435–436

**DRothers**, 362

**DRs (designated routers)**, 362–363  
 IS-IS, 373

**DS field (IPv4)**, 226

**DS0 (digital service zero)**, 500

**DSL (Digital Subscriber Line)**, 162

**DSSS (direct-sequence spread spectrum)**, 114

**DTMF (dual tone multi-frequency)**, 508

**DUAL (Diffusing Update Algorithm)**, 336–337

**dual-stack backbones IPv6 deployment model**, 276–277

**dual-tier Enterprise Branch design**, 204

**DVMRP (distance-vector multicast routing protocol)**, 414

**DWDM (Dense Wave Division Multiplexing)**, 166

**dynamic address assignment of IPv4 addresses**, 242

**Dynamic NAT**, 232

**dynamic routing protocols**, 293

**E**

**E&M (Ear and Mouth) signaling**, 503, 505

**E.164 standard**, 508

**eBGP**, 391

**E-Commerce submodule (Enterprise Edge Module)**, 45

**edge distribution module for campus LANs**, 91

**EGPs (exterior gateways protocols)**, 294  
*BGP*. *See BGP*

**EIGRP (Enhanced IGRP)**, 296, 334  
 DUAL, 336–337  
 IPv6 support, 274, 341–342  
 metrics, 337–339  
 neighbor discovery and recovery, 335–336  
 network design, 340  
 packets, 339  
 protocol-dependent modules, 335  
 RTP, 336  
 timers, 337

**encryption**, 447

**encryption keys**, 447

**enhanced features of IPv6**, 260–261

**Enterprise Branch architecture**, 200  
 SONA profiles, 201  
*dual-tier design*, 204  
*multi-tier design*, 205–206  
*single-tier design*, 203

**Enterprise Branch module**, 50

**Enterprise Campus Module**, 43

**Enterprise Data Center**  
 implementing security, 484  
 infrastructure, 94

**Enterprise Data Center module**, 51

**Enterprise Edge**  
 hardware  
*selecting*, 196  
*software, comparing*, 199–200

interconnections, 155  
 PDIOO methodology, 167–168  
 security, implementing, 484  
 software selection, 196  
*Cisco IOS Software*, 197–198

**Enterprise Edge Module**, 45  
 E-Commerce submodule, 45  
 Internet Edge submodule, 46–47  
 VPN/Remote Access submodule, 47–48

**Enterprise Teleworker design**, 207

**Enterprise Teleworker module**, 51

**Enterprise WAN design**, 192–193  
 Cisco Enterprise MAN/WAN, 193–195

**Enterprise WAN Module**, 48–49

**EoIP**, 134

**Erlang B**, 511

**Erlang C**, 511

**Ethernet network design guidelines**  
 10-Gigabit Ethernet, 79  
 10-Mbps, 74  
 100-Mbps, 74  
 100BASE-FX Fast Ethernet, 75  
 100BASE-T Fast Ethernet, 75  
 100BASE-T4 Fast Ethernet, 75  
 100BASE-TX Fast Ethernet, 75  
 Fast EtherChannel, 79  
 Gigabit Ethernet, 76–78  
 specifications, 73

**examples**  
 of hierarchical network model, 40  
 of layered communication, 625–626  
 of subnet design, 235  
 of VLSM address assignment, 237–239

**Extended Erlang B**, 511

**extranet VPNs**, 189

**F**

**Falcon Communications scenario**, 579, 581

**Fast EtherChannel**, network design guidelines, 79

**Fast Ethernet**, network design rules, 74  
 100BASE-FX, 75  
 100BASE-T, 75  
 100BASE-T4, 75  
 100BASE-TX, 75

**feasible successors**, 336

**FHSS (frequency-hopping spread spectrum)**, 114

**fields of IPv6 header**, 261–262

**firewalls as Cisco Self-Defending Network technology**, 470

**flat routing protocols**, 297

**floating static routes**, 58

**flooding**, 82

**flow control**, 622

**flush timer (RIP)**, 323

**forwarding information base (RIPv1)**, 321

**forwarding information base (RIPv2)**, 325

**FP (format prefix)**, 265

**fragmentation and reassembly of IPv4 packets**, 227–228

**Frame Relay**, 159  
 DE bit, 159  
 LMI, 159

**full-mesh networks**, 159

**full-mesh topologies**, 186

**FXO (Foreign Exchange Office)**, 503

**FXS (Foreign Exchange Station)**, 503

**G**

**gatekeepers**, calculating logical connections, 525

**gathering network information**, 17

**GetBulk operation**, 552

**Gigabit Ethernet**, network design guidelines, 76  
 1000BASE-CX, 78  
 1000BASE-LX, 77–78  
 1000BASE-T, 78

**GLBA (Gramm-Leach Bliley Financial Services Modernization Act of 1999)**, 432

**GLBP (Gateway Load Balancing Protocol)**, 54

**global unicast addresses (IPv6)**, 267

**GoS (Grade of Service)**, 511

**GPRS (General Packet Radio Service)**, 164

**GRE (Generic Routing Encapsulation)**, 192

**ground-start signaling**, 504

**group-membership LSAs (OSPFv3)**, 370

**H**

**H.323**, 523–524  
**hardware compression**, 170  
**header fields**  
 of IPv4, 222–224  
*DS*, 226  
*ToS*, 225–226  
 of IPv6, 261–262  
**Hello packets**  
 EIGRP, 339  
 OSPF, 359  
**hexadecimal numeric system**, 626  
 converting to decimal, 629–630  
**hierarchical LAN architecture**, 36  
 access layer, 39–40, 86–87  
 core layer, 38, 88  
 distribution layer, 38–39, 87–88  
 examples of, 40  
**hierarchical routing protocols**, 297  
**high-availability network designs**  
 media redundancy, 57–58  
 route redundancy, 55–56  
 server redundancy, 55  
 workstation-to-router redundancy, 52  
*ARP*, 53  
*explicit configuration*, 53  
*GLBP*, 54  
*HSRP*, 53–54  
*RDP*, 53  
*RIP*, 53  
**HIPAA (U.S. Health Insurance Portability and Accountability Act)**, 432  
**HIPS (host-based IPS)**, 475  
**holddown timer (RIP)**, 323  
**hop count**, 301  
**host-to-host transport layer (TCP/IP protocol)**, 625  
**hosts per subnet**, calculating, 235  
**H-REAP (hybrid REAP)**, 137  
**HSRP (Hot Standby Routing Protocol)**, 53–54  
**hub-and-spoke topologies**, 186  
**hubs**, 82  
**hybrid protocols**. *See advanced distance-vector protocols*

**I**

**IANA (Internet Assigned Numbers Authority)**, 390  
 IPv4 address space allocation, 229  
**iBGP**, 392  
 route reflectors, 393–395  
 uses of, 393  
**ICMPv6**, 270  
 messages, 271  
**identifying**  
 customer requirements, 15–16  
 network portion of IP addresses, 236  
**identity**, 444  
 certificates, 446  
 passwords, 445  
 tokens, 445  
**IDM (Cisco Intrusion Prevention System Device Manager)**, 478  
**IEEE 802.1X-2001**, 118  
**IEEE 802.3**, 73  
**IGMP (Internet Group Membership Protocol)**  
 multicasting, 409  
**IGMP snooping**, 97, 411  
**IGMPv1**, multicasting, 409  
**IGMPv2**, multicasting, 409  
**IGMPv3**, multicasting, 410  
**IGPs (interior gateway protocols)**, 294  
**IGRP (Interior Group Routing Protocol)**, 330  
 metrics, 331–333  
 network design, 333  
 timers, 331  
**IIN (Intelligent Information Network Framework)**, 8  
**immediate start signaling**, 505  
**Implement phase of PDIOO lifecycle**, 14  
**increasing availability**, 56  
**Inform operations**, 552  
**informational signaling**, 503  
**infrastructure, hardening**, 451–452  
**inside global addresses**, 233  
**inside local addresses**, 233  
**Integrated Application**, 9  
**Integrated Service**, 9  
**Integrated Transport**, 9  
**integrity violations**, 436

**Interactive Service layer (SONA), 10–11**

- application networking services, 11
- infrastructure services, 11

**Inter-Area-Prefix LSAs (OSPFv3), 370**

**Inter-Area-Router LSAs (OSPFv3), 370**

interdomain routing protocols, 390

internal routers, 361, 368

**Internet Edge submodule (Enterprise Edge Module), 46–47**

**Internet layer (TCP/IP protocol), 625**

interoffice trunks, 502

intertoll trunks, 502

**Intra-Area-Prefix LSAs (OSPFv3), 371**

intracontroller roaming, 127

intranet VPNs, 189

invalid timer (RIP), 323

**IP address field**

- RIP messages, 322
- IPv2 messages, 326

**IP multicast, 407**

- CGMP, 411
- DVMRP, 414
- IGMP, 409
- IGMP snooping, 411
- IGMPv1, 409
- IGMPv2, 409
- IGMPv3, 410
- Layer 3 to Layer 2 mapping, 408
- multicast addressing, 407
- multicast distribution trees, 412
- PIM, 413
- shared trees, 412

**ip subnet-zero command, 235**

**IPsec (IP Security), 117, 192, 273, 448–449**

**IPP**

- CME deployment model, 520
- components of, 516
- design recommendations, 533
- multisite centralized WAN call-processing deployment model, 519
- multisite distributed WAN call-processing deployment model, 519
- single-site deployment model, 518

**IPv4**

- address assignment
  - using ARP, 244–245*
  - using DHCP, 242–243*
  - using DNS, 243*

- address classes, 228–229
  - class A addresses, 230*
  - class B addresses, 230*
  - class C addresses, 230*
  - class D addresses, 230*
  - class E addresses, 231*
- BOOTP, 242
- comparing with IPv6, 277
- DSCP AF codepoint values, 227
- dynamic address assignment, 242
- header fields, 222–224
  - DS, 226*
  - ToS, 225–226*
- NAT, 232
- packet fragmentation and reassembly, 227–228
- private addresses, 231
- routing protocols, 299
- static address assignment, 242
- subnetting, 233
  - CIDR, 240*
  - example designs, 235*
  - hosts per subnet, calculating, 235*
  - loopback addresses, 239*
  - network portion, identifying, 236*
  - reserving subnets for VoIP devices, 239*
  - route summarization, 240–241*
  - subnet masks, 233–234*
  - VLSMs, 237–239*

**IPv4-compatible addresses (IPv6), 267**

**IPv6**

  - address allocation, 265–266
  - global unicast addresses, 267*
  - IPv4-compatible addresses, 267**
  - link-local addresses, 267*
  - loopback addresses, 266*
  - multicast addresses, 268–269*
  - site-local addresses, 268*
  - unspecified addresses, 266*
  - address assignment methods
    - DHCPv6, 273*
    - link-local address autoconfiguration, 273*
  - address representation, 262–263
  - anycast addresses, 265
  - comparing with IPv4, 277

deployment models  
*dual-stack backbones*, 276–277  
*IPv6 over dedicated WAN links*, 275  
*IPv6 over IPv4 tunnels*, 276  
*protocol translation mechanisms*, 277  
enhancements over IPv4, 260–261  
FP, 265  
header fields, 261–262  
IPv4-compatible addresses, 263  
IS-IS, 375  
multicast addresses, 265, 415  
OSPFv3, 367  
path MTU discovery, 272  
prefix allocation, 266  
prefix representation, 264  
routing protocols, 299  
security, 273  
supported routing protocols, 273–274  
*BGP4 multiprotocol extensions*, 274  
*EIGRP*, 274  
*IS-IS*, 274  
*OSPFv3*, 274  
*RIPng*, 274  
underlying protocols  
*ICMPv6*, 270  
*ND protocol*, 271–272  
unicast addresses, 265  
**IPv6 prefix field (RIPng)**, 329  
**ISDN (Integrated Services Digital Network)**,  
**157–158**  
BRI, 158, 506  
PRI, 158, 503, 506  
**IS-IS (Intermediate System-to-Intermediate System)**  
areas, 374  
authentication, 375  
DRs, 373  
for IPv6, 375  
IPv6 support, 274  
L1/L2 routers, 374  
metrics, 372  
NET, 373  
**ISM frequencies**, 115  
**ISR (Integrated Services Router)**, 468  
**IVR (interactive voice response)**, 510

**J-K**

**jitter**, 529  
**joining (PIM-SM)**, 413  
**Kismet**, 433

**L**

**L1/L2 routers**, 374  
**LACNIC (Latin America and Caribbean Network Information Center)**, 229  
**LANs**  
campus LANs, 85, 90  
*edge distribution module*, 91  
*QoS considerations*, 95–96  
Enterprise data center infrastructure, 94  
hardware  
*bridges*, 82  
*hubs*, 82  
*Layer 3 switches*, 85  
*repeaters*, 81  
*routers*, 84–85  
*switches*, 83–84  
hierarchical  
*access layer*, 86–87  
*core layer*, 88  
*distribution layer*, 87–88  
large-building LANs, 89  
medium-sized, 91  
multicast considerations, 96  
*CGMP*, 97  
*IGMP snooping*, 97  
server-farm module, 92  
*server connectivity options*, 93  
small and remote site LANs, 92  
**large-building LANs**, 89  
**Layer 1 (OSI model)**, 620–621  
**Layer 2 access methods on WLANs**, 116  
**Layer 2 intercontroller roaming**, 128  
**Layer 3 discovery (LWAPP)**, 123  
**Layer 3 intercontroller roaming**, 128  
**Layer 3 (OSI model)**, 622  
**Layer 3 switches**, 85  
**Layer 3 tunneling**, 192  
**Layer 4 (OSI model)**, 622  
**Layer 5 (OSI model)**, 623  
**Layer 6 (OSI model)**, 623

**Layer 7 (OSI model),** 623  
**layered communication, examples of,** 625–626  
**layers of hierarchical network design**  
 access layer, 39–40  
 core layer, 38  
 distribution layer, 38–39  
**LEAP (Lightweight Extensible Authentication Protocol),** 117–118  
**leased lines,** 185  
**legislation, security-related,** 432  
**Level 1 ISs,** 372  
**Level 1 routers,** 374  
**Level 2 ISs,** 372  
**Level 2 routers,** 374  
**LFI (link fragmentation and interleaving),** 530  
**Link LSAs (OSPFv3),** 371  
**link-local addresses (IPv6),** 267  
 autoconfiguration, 273  
**link-state routing protocols,** 296  
 IS-IS. *See* IS-IS  
 OSPF. *See* OSPF  
 versus distance-vector routing protocols, 297  
**LLQ (Low-Latency Queuing),** 171, 531  
**LMI (Local Management Interface),** 159  
**load balancing,** 55, 190  
**load metric,** 303  
**local loop,** 501  
**local mode (LWAPP),** 122  
**local preference attribute (BGP),** 397  
**logical link sublayer,** 621  
**loop prevention schemes,** 300–301, 305  
 counting to infinity, 306  
 split horizon, 305  
 triggered updates, 306  
**loopback addresses,** 239  
 IPv6, 266  
**loop-start signaling,** 504  
**LSAs (link-state advertisements),** 363  
 for OSPFv3, 368–370, 371  
**LWAPP (Lightweight Access Point Protocol),** 121  
 access point modes, 122–123  
 Layer 3 discovery, 123

## M

**MAC (Media Access Control) sublayer,** 621  
**maintaining security policies,** 442  
**mandatory well-known attributes (BGP),** 396  
 AS path, 398  
 next-hop, 397  
 origin, 398  
**MAPs (mesh access points),** 135  
**MBONE (multicast backbone),** 414  
**MBSA (Microsoft Baseline Security Analyzer),** 434  
**MD5 authentication,** 325  
**MED attribute (BGP),** 398–399  
**media redundancy,** 57–58  
**medium-sized LANs,** 91  
**messages**  
 ICMPv6, 271  
 RIPng, 329  
 RIPv1, 321  
 RIPv2, 326–327  
 SNMP, 550  
*SNMPv1*, 550–551  
*SNMPv2*, 551  
*SNMPv3*, 552  
 Syslog, 557  
**Metric field**  
 RIP messages, 322  
 RIPng messages, 329  
 RIPv2 messages, 327  
**metrics,** 293, 300–301  
 bandwidth, 301  
 configuring for redistributed routes, 406  
 cost, 302–303, 359  
 delay, 303  
 EIGRP, 337, 339  
 hop count, 301  
 IGRP, 331–333  
 IS-IS, 372  
 load, 303  
 MTU, 304  
 reliability, 304  
**MGCP (Media Gateway Control Protocol),** 523  
**MIB (management information base),** 549–550  
**mobile wireless implementations,** 164  
**mobility groups,** 130  
**monitor mode (LWAPP),** 122

- MOSPF (Multicast Open Shortest Path First),** 412
- MPLS (Multiprotocol Label Switching),** 161
- PPP (Point-to-Point Protocol),** 58
- MTU (maximum transmission unit),** 304
- multiaccess networks, DRs,** 362–363
- multicast,** 407
  - CGMP, 411
  - DVMRP, 414
  - IGMP, 409
  - IGMP snooping, 411
  - IGMPv1, 409
  - IGMPv2, 409
  - IGMPv3, 410
  - IPv6 addresses, 265, 268–269, 415
  - Layer 3 to Layer 2 mapping, 408
  - PIM, 413
    - shared trees, 412
  - multicast addressing,** 407
  - multicast distribution trees,** 412
  - multicast LAN considerations,** 96–97
  - multiservice networks**
    - IPT
      - CME deployment model,* 520
      - components,* 516
      - multisite centralized WAN call-processing deployment model,* 519
      - multisite distributed WAN call-processing deployment model,* 519
      - single-site deployment model,* 518
    - VoATM, 514
    - VoFR, 513–514
    - VoIP, 514, 516
  - multisite centralized WAN call-processing deployment model (IPT),** 519
  - multisite distributed WAN call-processing deployment model (IPT),** 519
  - multi-tier Enterprise Branch design,** 205–206
- N**
  - N+1 redundancy,** 130
  - N+N redundancy,** 131
  - N+N+1 redundancy,** 132
  - NAC as Cisco Self-Defending Network technology,** 471
  - name resolution for IPv6 addresses,** 272
- NANP (North American Numbering Plan),** 509
- NAT (network address translation),** 232
- ND (Network Discovery) protocol,** 271–272
- neighbors**
  - BGP, 391
  - EIGRP discovery and recovery, 335–336
  - OSPF adjacencies, 360
- Nessus,** 433
- NET addresses,** 373
- NetFlow,** 554
  - versus RMON,* 555
- NetStumbler,** 433
- network analysis tools,** 20
- network audit tools,** 17, 19–20
- network checklist,** 20–21
- network infrastructure layer (SONA),** 9–10
- network interface layer (TCP/IP protocol),** 624
- network layer (OSI model),** 622
- network LSAs (OSPFv3),** 363, 370
- network management**
  - CDP, 555–556
  - NetFlow, 554
    - versus RMON,* 555
  - RMON, 552
    - RMON2, 553
  - SNMP, 548
    - components of,* 548
    - messages,* 550–552
    - MIBs,* 549–550
  - Syslog, 556–557
- network phases of Cisco Self-Defending Networks,** 469
- network portion of IP addresses, identifying,** 236
- networks, characterizing,** 17
  - network analysis tools, 20
  - network audit tools, 17–20
  - network checklist, 20–21
- Next hop field (RIPv2),** 327
- next-hop attribute (BGP),** 397
- nibbles,** 631
- NMAP (Network Mapper),** 433
- nontransitive optional attributes (BGP),** 397
- nontransitive optional attributes (MED),** 398–399
- NSSA external LSAs,** 364
- NSSAs (not-so-stubby areas),** 365

**NT1 (network termination 1), 157**  
**NT2 (network termination 2), 157**

## O

**OC (Optical Carrier) speeds, 160**  
**ODR (on-demand routing), 307**  
**off-net calls, 500**  
**one-way redistribution, 405**  
**on-net calls, 500**  
**Operate phase of PDIOO lifecycle, 14**  
**Optimize phase of PDIOO lifecycle, 15**  
**optional attributes (BGP), 396**  
**optional nontransitive attributes, MED, 398–399**  
**optional transitive attributes, community, 399**  
**ordering WAN technologies, 166**  
  contract periods, 167  
  SLAs, 167  
**origin attribute (BGP), 398**  
**OSI model**  
  application layer, 623  
  data link layer, 621  
  layered communication, example of, 625–626  
  network layer, 622  
  physical layer, 620  
  presentation layer, 623  
  session layer, 623  
  transport layer, 622  
**OSPF (Open Shortest Path First)**  
  ABRs, 362  
  adjacencies, 359–360  
  areas, 360  
    *NSSAs, 365*  
    *stub areas, 364*  
    *totally stubby areas, 365*  
  AS external paths, 364  
  ASBRs, 362  
  backbone routers, 362  
  BDRs, 362–363  
  cost metric, 359  
  DRs, 362–363  
  Hello packets, 359  
  internal routers, 361  
  LSAs, 363  
  route redistribution, 406–407

router authentication, 366  
  virtual links, 366  
**OSPFv3, 367**  
  areas, 368  
  IPv6 support, 274  
  LSAs, 368–371  
  modifications from OSPFv2, 367–368  
  router types, 368  
**outside global addresses, 233**  
**outside local addresses, 233**  
**overlay VPNs, 189**

## P

**packets, 622**  
  EIGRP, 339  
  IPv4, fragmentation and reassembly, 227–228  
  OSPF. *See LSAs*  
**packet-switched WANs, 185**  
**partial-mesh topologies, 187**  
**passwords, 445**  
**PAT (port address translation), 232**  
**path MTU discovery, 272**  
**PBR (policy-based routing), 402**  
**PBXs, 500**  
  Q.SIG, 506  
**PCM (Pulse Code Modulation), 520**  
**PDIOO lifecycle, 13, 167–168**  
  Design phase, 14  
    *top-down design process, 21–22*  
  Implement phase, 14  
  Operate phase, 14  
  Optimize phase, 15  
  Plan phase, 14  
  Prepare phase, 14  
**PE (provider edge) routers, 161**  
**Pearland Hospital scenario, 569–571, 573**  
**peer-to-peer VPNs, 189**  
**physical layer (OSI model), 620**  
**physical media specifications for 10 Gigabit Ethernet, 79**  
**physical security, 450–451**  
**pilot sites, 22**  
**PIM (Protocol Independent Multicast), 413–414**

**PIM-SM (Protocol Independent Multicast-Sparse Mode), 412**  
 joining, 413  
 pruning, 413  
**PIMv2 BSR (bootstrap router), 414**  
**pinhole congestion, 55**  
**Plan phase of PDIOO lifecycle, 14**  
**policing, 172**  
**port scanning tools, 433**  
**port-based authentication, 118**  
**ports, 503**  
**PQ (Priority Queuing), 170**  
**PQ-WFQ, 531**  
 prefix allocation for IPv6, 266  
**Prefix length field (RIPng), 329**  
**prefix representation of IPv6, 264**  
**Prepare phase of PDIOO lifecycle, 14**  
**presentation layer (OSI model), 623**  
**preventing DoS attacks, 435–436**  
**PRI (Primary Rate Interface), 157–158, 503, 506**  
**private IPv4 addresses, 231**  
**processing delay, 529**  
**propagation delay, 529**  
**protocol translation, IPv6 deployment model, 277**  
**protocol-dependent modules, 335**  
**prototype networks, 22**  
**pruning PIM-SM, 413**  
**PSTN, 500**  
 E.164 standard, 508  
 NANP, 509  
 switches, 500–501  
**public networks, 232**  
**pulse dialing, 508**  
**purpose of security policies, 439**  
**PVCs (private virtual circuits), 159**

## Q

**Q.SIG, 506**  
**QoS, 170**  
 for campus LANs, 95–96  
 CBWFQ, 171  
 CQ, 171  
 LLQ, 171

on VoIP networks, 530  
*AutoQoS, 532–533*  
*CRPT, 530*  
*LFI, 530*  
*LLQ, 531*  
*PQ-WFQ, 531*  
**PQ, 170**  
 traffic shaping, 172  
**WFQ, 171**  
**quad-A records, 272**  
**quantization, 521**  
**Query packets (EIGRP), 340**  
**queuing delay, 529**

## R

**RAP (Rooftop AP), 135**  
**RDP, 53**  
**REAP mode (LWAPP), 122**  
**reconnaissance network tools, 433**  
**redistribution, 404–405**  
 default metric, 406  
 of OSPF routes, 406–407  
 two-way, 405  
**redundancy**  
 deterministic, 130  
 media, 57–58  
 N+1, 130  
 N+N, 131  
 N+N+1, 132  
 route, 55–56  
 server, 55  
 workstation-to-router, 52  
*ARP, 53*  
*explicit configuration, 53*  
*GLBP, 54*  
*HSRP, 53–54*  
*RDP, 53*  
*RIP, 53*  
**reliability metric, 304, 168**  
**Remote modules, 50**  
 Enterprise Branch module, 50  
 Enterprise Data Center module, 51  
 Enterprise Teleworker module, 51  
**remote-access networks, 187**  
**repeaters, 81**  
**Reply packets (EIGRP), 340**  
**representation of subnet masks, 234**

**reserved multicast addresses**, 407  
**reserving subnets for VoIP devices**, 239  
**response times**, 168  
**RF groups**, 133  
**RF site surveys**, 133  
**RFC 2196, security policies**, 438  
**RIP**, 53  
  counting to infinity, 322  
  triggered updates, 320  
**RIPE NCC (Reseaux IP Europeens Network Control Center)**, 229  
**RIPng**, 274, 299, 328  
  authentication, 328  
  message format, 329  
  network design, 330  
  timers, 328  
**RIPv1**, 320  
  flush timer, 323  
  forwarding information base, 321  
  holddown timer, 323  
  invalid timer, 323  
  message format, 321  
  network design, 323  
  update timer, 322  
**RIPv2**, 324  
  authentication, 325  
  forwarding information base, 325  
  message format, 326–327  
  network design, 327  
  timers, 327  
**RIR (Regional Internet Registries)**, 229  
**risk assessments**, 440–441  
**risk index**, 441  
**RMON**, 552  
  RMON2, 553  
  versus NetFlow, 555  
**RMON2**, 553  
**rogue detector mode (LWAPP)**, 122  
**root bridge**, 82  
**route redistribution**, 404–405  
  default metric, 406  
  of OSPF routes, 406–407  
  one-way, 405  
  two-way, 405  
**route redundancy**, 55–56  
**route reflectors**, 393–395  
  quad-A, 272  
**route summarization**, 403–404

**Route tag field**  
  RIPng, 329  
  RIPv2, 326  
**Router LSAs**, 363  
**routers**, 84–85  
  IS-IS, 374  
  OSPF, 361–362  
**routing by rumor**, 295  
**routing protocols**, 84  
  administrative distance, 299  
  advanced distance-vector  
    *EIGRP*, 334–339  
    *EIGRP for IPv6*, 341–342  
  classful, 298  
  classless, 298  
  distance-vector, 295–297  
    *EIGRP*, 296  
    *IGRP*, 330–333  
    *RIPv1*, 320–323  
    *RIPv2*, 324–327  
  dynamic routes, 293  
  EGPs, 294  
  flat, 297  
  hierarchical, 297  
  IGPs, 294  
  IPv4, 299  
  IPv6-supported, 273–274, 299  
    *BGP4*, 274  
    *EIGRP*, 274  
    *IS-IS*, 274  
    *OSPFv3*, 274  
    *RIPng*, 274  
  link-state, 296  
    *IS-IS*. *See IS-IS*  
    *OSPF*. *See OSPF*  
    *versus distance-vector*, 297  
  loop-prevention schemes, 300–301, 305  
    *counting to infinity*, 306  
    *split horizon*, 305  
    *split horizon with poison reverse*, 305  
    *triggered updates*, 306  
  metrics, 293, 300–301  
    *bandwidth*, 301  
    *cost*, 302–303  
    *delay*, 303  
    *hop count*, 301  
    *load*, 303  
    *MTU*, 304  
    *reliability*, 304

ODR, 307  
 static routes, 292  
 summarization, 306

**RP (rendezvous points)** 412  
 Auto-RP, 414  
 PIMv2 BSR, 414

**RTCP (Real-time Transport Control Protocol)**, 522–523

**RTP (Real-time Transport Protocol)**, 522–523

**S**

**SAINT (Security Administrator’s Integrated Network Tool)**, 433

**Sarbanes-Oxley Act**, 432

**scalability restraints**  
 for 10-Gigabit Ethernet, 79  
 for 10-Mbps Ethernet, 74  
 for Gigabit Ethernet, 76–77  
*1000BASE-CX*, 78  
*1000BASE-LX*, 77  
*1000BASE-SX*, 78  
*1000BASE-T*, 78  
 for Token Ring, 80

**scanning tools**, 433

**SCCP (Skinny Client Control Protocol)**, 522

**scenarios**, 569–581

**SCP (Signaling Control Point)**, 507

**secure connectivity**, 446

**security**  
 access control, 446  
 Cisco Self-Defending Networks, 467  
*network phases*, 469  
*trust and identity technologies*, 470–472  
*underlying security platforms*, 468  
 confidentiality breaches, 436–437  
 data integrity, 449  
 encryption, 447  
 encryption keys, 447  
 identity, 444  
*certificates*, 446  
*passwords*, 445  
*tokens*, 445  
 infrastructure, hardening, 451–452  
 integrating into network devices  
*Catalyst 6500 services modules*, 481–482

*Cisco IOS routers and switches*, 478  
*Cisco IPS*, 480–481  
*Cisco ISR*, 479  
*Cisco Security Appliances*, 480  
*CSA*, 482  
 integrity violations, 436  
 IPv6 mechanisms, 273  
 physical security, 450–451  
 risk assessments, 440–441  
 threat detection and mitigation techniques, 474–476  
*DoS attacks, avoiding*, 435–436  
*unauthorized access*, 434  
 transmission confidentiality, 449  
 trust, 443  
*Domains of Trust*, 443–444

**VPNs**  
*IPsec*, 448–449  
*SSL*, 448–449

**WLANs**, 116  
*access to servers, controlling*, 118–119  
*IEEE 802.1X-2001*, 118  
*LEAP*, 118  
*unauthorized access*, 117

**security management applications**, 476

**security policies**  
 components of, 440  
 creating, 438  
 maintaining, 442  
 purpose of, 439

**selecting RPs**, 414

**serialization delay**, 529

**server-farm module**, 92

**server redundancy**, 55  
 server connectivity options, 93

**Service Provider Edge Module**, 49

**session layer (OSI model)**, 623

**sessions**, 623

**shared trees**, 412

**show interface command**, 304

**show ip protocol command**, 323

**show ip rip database command**, 321

**show version command**, 18–20

**signaling**  
*CAS*, 506  
*E&M*, 505  
*ground-start*, 504  
*loop-start*, 504

Q.SIG, 506  
 SS7, 507  
**single-site deployment model (IPT), 518**  
**single-tier Enterprise Branch design, 203**  
**SIP (Session Initiation Protocol), 525–526**  
 site-local addresses (IPv6), 268  
 skinny protocols, 522  
 SLA (site-level aggregator), 267  
 SLAs (service-level agreements), ordering, 167  
**small and remote site LANs, 92**  
**Sniffer mode (LWAPP), 123**  
**SNMP (Simple Network Management Protocol), 548**  
 components of, 548  
 messages, 550–552  
 MIBs, 549–550  
**SNMPv1, 550–551**  
**SNMPv2, 551**  
**SNMPv3, 552**  
**social engineering, 434**  
**SONA (Service-Oriented Network Architecture), 9, 12, 42, 200**  
 Application layer, 11  
 Interactive Service layer, 11  
*application networking services, 11*  
*infrastructure services, 11*  
 Network Infrastructure layer, 10  
 profiles, 201  
*dual-tier design, 204*  
*multi-tier design, 205–206*  
*single-tier design, 203*  
**SONET/SDH (Synchronous Optical Network/Synchronous Digital Hierarchy), 160**  
 sparse multicast routing, 412  
 specifications, Ethernet, 73  
 SPF (shortest path first) algorithm, 358  
**split horizon, 305**  
 with poison reverse, 305  
**SRST (Survivable Remote Site Telephony), 516**  
**SS7 (Signaling System 7), 507**  
**SSIDs (service set IDs), 116**  
**SSL (Secure Sockets Layer), 448–449**  
**SSP (Signaling Switching Point), 508**  
 static address assignment of IPv4 addresses, 242  
**Static NAT, 232**

**static routes, 292**  
 administrative distance, 300  
**store-and-forward devices, 82**  
**STP (Signaling Transfer Point), 508**  
**STP (Spanning Tree Protocol), 82**  
 stub areas, 364–365  
 stub domains, 232  
**Subnet mask field (RIPv2), 326**  
**subnet masks, 233**  
 representation of, 234  
**subnetting, 233**  
 example designs, 235  
 hosts per subnet, calculating, 235  
 network portion of IP address, identifying, 236  
 subnet masks, 233  
*representation of, 234*  
**VLSMs, 237**  
*address-assignment example, 237–239*  
*CIDR, 240*  
*loopback addresses, 239*  
*reserving subnets for VoIP devices, 239*  
*route summarization, 240–241*  
**summarization, 306**  
 for subnetted IP addresses, 240–241  
**summarizing routes. *See route summarization***  
**Summary LSAs, 363**  
**Superscan, 433**  
**supervisory signaling, 503**  
**SVCs (switched virtual circuits), 159**  
**switches, 83–84**  
 Layer 3 switches, 85  
**switchport host command, 87**  
**Syslog, 556–557**

## T

**tandem trunks, 502**  
**targets of security breaches, 435**  
**TCP (Transport Control Protocol), window size, 169**  
**TCP/IP protocol layers**  
 application layer, 625  
 host-to-host transport layer, 625  
 Internet layer, 625

layered communication, example of, 625–626  
 network interface layer, 624  
**TDM (Time-Division Multiplexing), 160**  
**TE1 (terminal equipment 1), 157**  
**TE2 (terminal equipment 2), 157**  
 testing network designs, 22  
**TFTP (Trivial File Transport Protocol), 522**  
**Threat Defense, 450**  
 threat detection and mitigation techniques, 474–476  
 threats to security, unauthorized access, 434  
 throughput, 168  
 tie-lines, 502  
 tie trunks, 502  
 timers  
   EIGRP, 337  
   IGRP, 331  
   RIP, 322–323  
   RIPng, 328  
   RIPv2, 327  
**TLA (Top-Level Aggregator), 267**  
**Token Ring, network design rules, 80**  
 tokens, 445  
 toll-connecting trunks, 502  
 top-down design process, 21–22  
 ToS field (IPv4), 225–226  
 totally stubby areas, 365  
 traffic shaping, 172  
 transit autonomous systems, 392  
 transitive optional attributes (BGP), 397  
   community, 399  
 transport layer (OSI model), 622  
 transport protocols, TCP, 169  
 triggered updates, 295, 306, 320  
 trunks, 502  
 trust, 443  
   Domains of Trust, 443–444  
   identity, 444  
     *certificates, 446*  
     *passwords, 445*  
     *tokens, 445*  
**two-way redistribution, 405**  
**Type-7 LSAs (OSPFv3), 371**

**U**

**U.S. Health Insurance Portability and Accountability Act (HIPAA), 432**  
**U.S. Public Company Accounting Reform and Investor Protection Act of 2002, 432**  
**UBR (Universal Broadband Router), 163**  
**UMTS (Universal Mobile Telecommunications Service), 164**  
**unauthorized access, 434**  
   on WLANs, 117  
   protecting against, 434  
**unicast addresses for IPv6, 265**  
**UNII frequencies, 115**  
**unspecified addresses (IPv6), 266**  
**Update packets (EIGRP), 340**  
**update timer (RIP), 322**

**V**

**VAD (voice activity detection), 527–528**  
**variance, 55**  
**Version field**  
   RIP messages, 322  
   RIPng messages, 329  
   RIPv2 messages, 326  
**virtual links, 366**  
**VLSMs (variable-length subnet masks), 237**  
   address-assignment example, 237–239  
   CIDR, 240  
   loopback addresses, 239  
   reserving subnets for VoIP devices, 239  
   route summarization, 240–241  
**VoATM (Voice over ATM), 514**  
**VoFR (Voice over Frame Relay), 513–514**  
**voice mail, 510**  
**voice networks, 500**  
   ACD, 511  
   BHT, 512  
   blocking probability, 512  
   busy hour, 512  
   CCS, 512  
   CDRs, 512  
   Centrex services, 510  
   codes  
     *analog-to-digital signal conversion, 520*  
     *standards, 521*

- database services, 510
- DHCP, 522
- digital signaling, 503
- DNS, 522
- DTMF, 508
- Erlangs, 511
- GoS, 511
- H.323, 523–524
- IVR, 510
- local loop, 501
- MGCP, 523
- ports, 503
- PSTN, 500
  - ACD*, 511
  - Centrex services*, 510
  - database services*, 510
  - IVR*, 510
  - switches*, 500–501
  - voice mail*, 510
- pulse dialing, 508
- RTCP, 522–523
- RTP, 522–523
- SCCP, 522
- signaling
  - CAS*, 506
  - E&M*, 505
  - ground-start*, 504
  - loop-start*, 504
  - Q.SIG*, 506
  - SS7*, 507
- SIP, 525–526
- TFTP, 522
- voice mail, 510
- VoIP design recommendations, 533
- VoIP, 514–516**
  - bandwidth, VAD, 527–528
  - delay components, 528, 530
  - design recommendations, 533
  - QoS mechanisms, 530
    - AutoQoS*, 532–533
    - CRPT*, 530
    - LFI*, 530
    - LLQ*, 531
    - PQ-WFQ*, 531
- VPDNs (virtual private dialup networks), 189**
- VPN/Remote Access submodule (Enterprise Edge Module), 47–48**

- VPNs, 187**
  - access VPNs, 188
  - benefits of, 189
  - extranet VPNs, 189
  - intranet VPNs, 189
  - IPSec, 448–449
  - overlay VPNs, 189
  - peer-to-peer, 189
  - SSL, 448–449
  - VPDNs, 189
- vulnerability scanners, 433**

## W

- WANs, 154**
  - backup options, 190–191
  - bandwidth considerations, 169
  - broadband cable, 163
  - cell-switched, 185
  - circuit-switched, 185
  - comparing, 156–157
  - dark fiber, 166
  - DSL, 162
  - DWDM, 166
  - enterprise architecture, 192–193
  - Cisco Enterprise MAN/WAN*, 193–195
- Enterprise Branch design, 200
  - dual-tier design*, 204
  - multi-tier design*, 205–206
  - single-tier design*, 203
  - SONA profiles*, 201
- Enterprise Edge, 155
  - hardware selection*, 196
  - hardware/software comparison*, 199–200
  - software selection*, 196–198
- Enterprise Teleworker design, 207
- Frame Relay, 159
  - DE bit*, 159
  - LMI*, 159
- full-mesh topology, 186
- hub-and-spoke topology, 186
- interconnections, 155
- ISDN, 157–158
  - BRI service*, 158
  - PRI service*, 158
- Layer 3 tunneling, 192
- leased lines, 185

- MPLS, 161
- ordering, 166–167
- packet-switched, 185
- partial-mesh topologies, 187
- QoS, 170
  - CBWFQ*, 171
  - CQ*, 171
  - LLQ*, 171
  - policing*, 172
  - PQ*, 170
  - traffic shaping*, 172
  - WFQ*, 171
- security, implementing, 484
- SLAs, ordering, 167
- SONET/SDH, 160
- TDM, 160
- WCS (Wireless Control System)**, 135
- WECA (Wireless Ethernet Compatibility Alliance)**, 114
- weight attribute (BGP)**, 400
- well-known attributes (BGP)**, 396
- well-known discretionary attributes**
  - atomic aggregate, 399–400
  - local preference, 397
- well-known mandatory attributes**
  - AS path, 398
  - next-hop, 397
  - origin, 398
- well-known multicast addresses**, 407
- WEP (Wireless Equivalent Privacy)**, 116
- WFQ (Weighted Fair Queuing)**, 171
- wide metrics (IS-IS)**, 372
- Wi-Fi**, 114
- window size, 169
- wink start signaling, 505
- wireless bridges, 165
- wireless mesh, 134–135
- wireless technologies, mobile wireless, 164
- WLANs (wireless LANs)**, 165
  - access to servers, controlling, 118–119
  - Cisco UWN, 119
    - branch design considerations*, 137
    - campus design considerations*, 136–137
    - intracontroller roaming*, 127
    - Layer 2 intercontroller roaming*, 128
    - Layer 3 intercontroller roaming*, 128
    - LWAPP*, 121–123
    - mobility groups*, 130
  - radio management*, 132–133
  - RF site surveys*, 133
  - wireless mesh*, 134–135
  - WLAN authentication*, 124–125
  - WLAN controller components*, 125–127
  - ISM frequencies, 115
  - Layer 3 access methods, 116
  - security, 116
    - IEEE 802.1X-2001*, 118
    - LEAP*, 118
    - unauthorized access*, 117
  - SSID, 116
  - standards, 115–116
  - UNII frequencies, 115
  - wireless mesh, 135
  - WLCs**
    - N+1 redundancy*, 130
    - N+N redundancy*, 131
    - N+N+1 redundancy*, 132
    - redundancy*, 130
  - WLCs (Wireless LAN Controllers)**, 135
  - redundancy
    - N+1*, 130
    - N+N*, 131
    - N+N+1*, 132
  - workstation-to-router redundancy**, 52
    - ARP, 53
    - explicit configuration, 53
    - GLBP, 54
    - HSRP, 53–54
    - RDP, 53
    - RIP, 53

## X-Y-Z

xDSL, 162