

Index

Note to the Reader: Throughout this index **boldfaced** page numbers indicate primary discussions of a topic. *Italicized* page numbers indicate illustrations.

A

accept action
 for firewall filters, 321
 ICMP policing, 308
 RE, 285
 transit, 301
 for LSP-to-prefix mapping, 189
 for multifield classification, 626

accept-all action
 for firewall filters, 321
 Filter Based Forwarding, 326
 transit, 302
 for traffic sampling, 331

access-log term, 353–354

activate label-switched-path
 command, 211

activate protocols dvmrp command, 428

active prefixes for MPLS
 case study, 234
 installing, 177–178
 for routing table integration, 172
 verifying, 178–179

actual bandwidth for CSPF, 162

adaptive keyword for MPLS
 case study, 238–239
 for secondary paths, 198

addresses
 families, 625
 IPv6, 510–513, 512
 assigning, 513–515
 and neighbor discovery, 522
 verifying, 515–520

adjacencies
 with firewall filters, 280
 in IGP discovery, 8, 73
 in IS-IS routing protocol, 5

adjust-interval setting, 222

administration groups for CSPF, 163

advertise-inactive option
 in EBG, 29–30, 33
 in IBGP, 23

advertisements, router
 configuring, 515
 verifying, 520–521

AF (Assured Forwarding), 624

affinities for CSPF, 163

aggregate routes
 for EBG, 26–27, 30, 545
 for IBGP, 560
 for IGP, 77–78, 80
 for MPLS, 245–246

aggressive setting for preemption, 208

all keyword in MPLS, 130

announce messages, Auto-RP, 456

Any-Cast technique
 with MSDP
 configuring, 465–470, 466
 verifying, 470–472
 in PIM-SM, 430

AnyCast group, 510

applying firewall filters
 RE, 286–299
 transit, 303–307

ASNs (Autonomous System Numbers),
 21, 700

Assured Forwarding (AF), 624

auto-bandwidth feature for MPLS, 220

Auto-RP for PIM SM, 430
 configuring, 455–459, 455
 verifying, 459–463

automatic bandwidth reservations, 220–223

automatic prefix installation, 179

Autonomous System Numbers (ASNs),
 21, 700

B

BA (behavior aggregate) classification,
 624, 631
 configuring, 631–634
 verifying, 634–635

backwards routing, 441

bandwidth
 reservations
 in CSPF, 162
 in MPLS, 220–223
 for secondary paths, 195
 bandwidth-limit option, 364
 bandwidth-percent option, 364
 baseline configurations
 IS-IS network, 82
 r1, 82–86
 r2, 86–90
 r3, 90–96
 r4, 96–102
 r5, 102–106
 r6, 106–111
 r7, 111–116
 MPLS, 141–148, 142
 OSPF network, 37
 in MPLS case study, 224–247, 224
 r1, 37–40
 r2, 40–44
 r3, 44–49
 r4, 49–53
 r5, 53–57
 r6, 57–61
 r7, 62–66
 BE (Best Effort) forwarding, 624
 BE traffic, schedulers for
 configuring, 651–655
 verifying, 655–659
 behavior aggregate (BA) classification,
 624, 631
 configuring, 631–634
 verifying, 634–635
 Best Effort (BE) forwarding, 624
 best-effort counter, 630
 BGP
 for IPv6, 540–541, 541–542
 port assignments for, 345
 and static routing
 configuring, 708–712, 709
 verifying, 712–727
 bgp-ospf export policy, 738
 bgp term in firewall filter case study, 353
 BOOT service port assignments, 345
 bootstrap protocol in PIM-SM, 430
 configuring, 441–445, 443
 verifying, 445–455
 broadcast trees, 430
 bundles for MPLS, 245
 bypass-routing, 139

C

c1-c2-vpn policy, 732
 c1-export policy, 745
 c1-in filter, 299–301, 305, 325–326
 c1-ospf routing instance, 737–738
 c1-out filter, 301–303, 305–307
 C1 router
 for CoS case study, 670–671
 for firewall filters
 case study, 355–356, 372–374
 Filter Based Forwarding, 327
 for IPv6 tunneling, 577
 for LDP signaled LSP verification, 138–139
 for VPNs
 with BGP and static routing, 716–717,
 719, 723
 case study, 785
 draft-Kompella, 748–750
 Internet access from non-VRF
 interface, 764–765
 with OSPF, 729–731, 739
 redundancy and route filtering, 741–744
 c1-syns counter, 301, 303–304
 c2-export policy, 732–733
 c2-import policy, 732
 c2-ospf policy, 731–735, 737
 C2 router for VPNs
 draft-Kompella, 760
 draft-Martini, 772–773
 Internet access from non-VRF
 interface, 765–766
 Layer 3, 717–720, 724
 C3 router for VPN case study, 794–795
 C4 router for VPN case study, 793, 797–798,
 803, 806
 case studies
 CoS, 667–669
 analysis, 669–680
 configurations, 680–688
 firewall filters, 346–349, 346, 348
 analysis, 349–376
 configurations, 376–393
 IPv6, 578–579, 579–580
 analysis, 580–597
 configurations, 597–615
 MPLS and traffic engineering, 223–226,
 224–225
 analysis, 226–247
 configurations, 247–268

- multicast, 480–481, 481
 - analysis, 481–494, 482
 - configurations, 494–499
- network discovery and validation
 - analysis, 67–82, 82
 - configurations, 82–116
- VPNs, 775–776, 775, 777
 - analysis, 778–807
 - configurations, 807–819
- CCC (Circuit Cross Connect), 747
- Cell Loss Priority (CLP) bit, 642
- cflowd export, 334–335
 - configuring, 335
 - verifying, 335–337
- Circuit Cross Connect (CCC), 747
- Class of Service. *See* CoS (Class of Service)
- classifier filter, 628
- classify filter, 626–627, 629, 631
- clear firewall all command
 - for firewall filters
 - case study, 364, 372
 - prefix-specific counting, 320
 - for VPN case study, 806
- clear igmp statistics command, 410
- clear interfaces statistics command, 629
- clear mpls lsp command, 169–171
- CLP (Cell Loss Priority) bit, 642
- commit command
 - for CoS
 - DSCP rewrites, 639
 - schedulers, 659
 - for firewall filters
 - RE, 288, 293
 - transit, 303
 - for IPv6
 - EBGP, 545
 - OSPF, 540
 - RIPng, 525
 - tunneling, 563
 - for MPLS
 - LSP forwarding, 215–217
 - LSP policing, 312
 - preemption, 211
 - processing enabling, 131
 - RSVP signal enabling, 149
 - RSVP signaled LSPs, 153, 157
 - secondary paths, 200–201
 - for multicast
 - case study, 487
 - DVMRP, 428
 - PIM DM, 432
 - PIM SM, 463
 - for VPNs
 - case study, 788, 792
 - draft-Martini, 770
- commit and-quit command, 407–408
- commit check command, 774
- commit complete message command, 287
- commit confirmed command for firewall filters
 - benefits of, 321
 - case study, 356
 - RE, 287
- configure command, 356
- configuring
 - COS
 - BA classification, 631–634
 - case study, 680–688
 - DSCP rewrites, 636–639
 - loss priority, 642–646, 643
 - multifield classification, 625–628
 - RED profiles, 661–664
 - schedulers, 651–655
 - firewall filters
 - case study, 376–393
 - cflowd export, 335
 - Filter Based Forwarding, 322–326
 - ICMP policing, 307–308
 - port mirroring, 338–340, 338
 - PSCP, 314–316
 - traffic sampling, 330–332
 - IPv6
 - case study, 597–615
 - EBGP peering, 542–543
 - IBGP peering, 546–558
 - OSPF, 533–534
 - RIPng, 523–529, 524–525
 - router advertisements, 515
 - tunneling, 562–567, 566
 - MPLS and traffic engineering
 - case study, 247–268
 - CSPF constrained LSPs, 167–169
 - ERO constrained LSPs, 158–159
 - Fast Reroute, 203–204
 - link protection, 205–206
 - LSP-to-prefix mapping, 185–191
 - preemption, 209–214
 - RSVP signaled LSPs, 151–154
 - multicast
 - case study, 494–499

- DVMRP, 413–416
- IGMP, 407–408
- MSDP interdomain, 472–475, 473
- MSDP with Any-Cast, 465–470, 466
- PIM DM, 431–433
- PIM SM using Auto-RP, 455–459, 455
- PIM SM using bootstrap, 441–445, 443
- VPNs
 - with BGP and static routing, 708–712, 709
 - case study, 807–819
 - draft-Kompella, 750–755
 - draft-Martini, 766–768
 - Layer 3, 700–707, 701
 - with OSPF, 731–736
- constrained routing in MPLS, 157–158
 - Constrained Shortest Path First algorithm
 - for, 124, 141, 161–163
 - link coloring for, 163–167, 163
 - for LSPs, 167–169
 - for RSVP signaled LSPs, 152–154
 - and TEDs, 158
 - troubleshooting, 169–171
 - ERO constraints, 158–161
 - SPF constraints, 161–171, 163
- convergence with multicast protocols, 408
- CoS (Class of Service), 620–623, 622
 - BA classification
 - configuring, 631–634
 - verifying, 634–635
 - case study, 667–669
 - analysis, 669–680
 - configurations, 680–688
 - classification summary, 635
 - firewall filters for, 277
 - loss priority, 642
 - configuring, 642–646, 643
 - verifying, 646–650
 - multifield classification, 624
 - configuring, 625–628
 - verifying, 628–631
 - packet classification and forwarding
 - classes, 623–624
 - RED profiles, 661
 - configuring, 661–664
 - verifying, 664–666
 - review questions, 689–691
 - review questions, answers to, 692–695
 - rewrite markers for, 635–636
 - DSCP rewrites configuration, 636–639

- DSCP rewrites verification, 639–642
 - summary, 650–651
 - schedulers, 651
 - configuring, 651–655
 - summary, 666
 - verifying, 655–659
 - summary, 666–667
- count action
 - for firewall filters
 - case study, 359
 - RE, 285
 - for IPv6 case study, 596
- CSPF (Constrained Shortest Path First)
 - algorithm, 124, 141, 161–163
 - link coloring for, 163–167, 163
 - for LSPs, 167–169
 - for RSVP signaled LSPs, 152–154
 - and TEDs, 158
 - troubleshooting, 169–171
- customer peering, 30–31

D

- data-center prefix action, 316
- data center routes, 18
- dc-pscp filter, 316–320, 368
- DC router
 - for IGP discovery, 15–16
 - for RE firewall filters, 297–299
- DCs (Demand Connections), 124
- DDoS (Distributed Denial of Service)
 - attacks, 276
- DE (Discard Eligibility) bit, 642
- deactivate interfaces fe-0/0/0 command, 563
- deactivate interfaces so-0/2/0 command
 - for draft-Martini VPNs, 770
 - for IPv6 tunneling, 563
 - for secondary paths, 200
- deactivate label-switched-path command, 211
- deactivate protocols command, 798
- deactivate protocols pim command for PIM SM
 - using Auto-RP, 462–463
 - using bootstrap, 453
- default keyword for multifield
 - classification, 634
- default routes
 - in IGP discovery, 16, 75
 - in IS-IS, 594–595
 - in NSSA, 11

- delete group command, 720
- delete label-switched-path command
 - for active prefixes, 177
 - for link protection, 205
 - for secondary paths, 195
 - for TE shortcuts, 180
- delete output command
 - for cflowd export, 335
 - for port mirroring, 339
- delete pim rp bootstrap-priority command, 456
- delete policy-options community c1-c2-rt command, 767
- delete policy-options community c1-c2-vpn command, 750
- delete policy-options community domain command, 751
- delete policy-options forwarding-table export command, 767
- delete policy-options policy-statement c1-c2 export command, 767
- delete policy-options policy-statement c1-c2 import command, 766
- delete policy-options policy-statement c1-import command, 750
- delete policy-options policy-statement mapping command, 767
- delete policy-options policy-statement ms1 command, 442
- delete protocols bgp group c2 command, 717
- delete protocols bgp group ext command, 792
- delete protocols bgp group p1 command, 792
- delete protocols dvmrp command, 431
- delete protocols isis export command, 442
- delete protocols isis traffic-engineering shortcuts command, 184
- delete protocols mpls label-switched-path command, 184
- delete protocols mpls path command, 184
- delete protocols mpls traffic-engineering command, 184
- delete protocols msdp traceoptions command, 476
- delete protocols ospf area 1 interface command, 788
- delete protocols pim command, 442
- delete protocols rsvp command, 767
- delete route command, 724
- delete routing-instances command for Layer 3 VPNs
 - draft-Kompella, 750
 - draft-Martini, 766
 - with OSPF, 731
- delete routing-options interface-routes command, 431
- delete routing-options rib command, 525
- delete routing-options rib-groups command, 431
- delete system authentication-order password command, 356
- delete then accept command, 308
- delete traceoptions command, 157
- Demand Connections (DCs), 124
- dense mode PIM (PIM DM), 430–431
 - configuring, 431–433
 - verifying, 433–440
- Dense option, 434
- deny-all action, 301, 321
- deny-all-else option, 284
- destination keyword, 338
- destination-port option for firewall filters
 - Filter Based Forwarding, 326
 - RE, 283
- destination-prefix-length option, 315
- DHCP service port assignments, 345
- DiffServ Code Point (DSCP), 624
 - classification, 642, 643
 - rewrites
 - configuring, 636–639
 - verifying, 639–642
- discard action for firewall filters, 321
 - case study, 359
 - ICMP policing, 308
 - RE, 285
- Discard Eligibility (DE) bit, 642
- discovery. *See* network discovery and verification
- discovery messages, Auto-RP, 456
- Distance Vector Multicast Routing Protocol (DVMRP), 412–413, 413
 - configuring, 413–416
 - metrics in, 425–427
 - summary, 429
 - tracing, 427–429
 - verifying, 416–427, 421
- Distributed Denial of Service (DDoS) attacks, 276
- DNS service port assignments, 345
- documenting discovery findings, 19
- domain community, 733
- domain-id, 732

downstream prefixes with TE shortcuts, 179
 draft-Kompella VPNs, 747–750, 748
 configuring, 750–755
 verifying, 755–766
 draft-Martini VPNs
 configuring, 766–768
 verifying, 769–773
 DSCP (DiffServ Code Point), 624
 classification, 642, 643
 rewrites
 configuring, 636–639
 verifying, 639–642
 dscp-default classifier, 633
 dscp-default rewrite tables, 636
 dscp-plp table, 644
 DVMRP (Distance Vector Multicast Routing Protocol), 412–413, 413
 configuring, 413–416
 metrics in, 425–427
 summary, 429
 tracing, 427–429
 verifying, 416–427, 421

E

E-FEB designation, 621
 E-FPCs (Enhanced Flexible PIC Concentrators), 620–621
 EBGP
 configuring, 542–543
 discovery, 24
 customer peering in, 30–31
 final checks, 34–35
 P1 peering in, 24–27
 r4 to C1 peering in, 32–34
 r7 to C1 peering in, 31–32
 summary, 35–36, 36
 T1 peering in, 28–30
 for IPv6 tunneling, 569–577
 verifying, 543–546
 ebgp-in policy, 29–30
 ebgp-out policy, 26, 30, 32–33
 echo-reply option, 281
 echo-request option, 281
 edit at-0/2/1 unit command, 513
 edit class-of-service schedulers best-effort command, 651
 edit family inet prefix-action data-center command, 314
 edit firewall filter command
 for multifield classification, 625
 for RE firewall filters, 281
 for traffic sampling, 330
 edit interfaces command
 for IPv6 tunneling, 567
 for Layer 3 VPNs, 701
 for LDP signaled LSPs, 126
 for MPLS baseline support, 142
 edit policy-options policy-statement command, 189
 edit protocols mpls command
 for LSP-to-prefix mapping, 188
 for TE shortcuts, 182
 edit protocols msdp group ext command, 472
 edit protocols rsvp command, 206
 edit rewrite-rules dscp command, 643
 edit routing-instances c1-c2-l2 command, 752
 edit routing-instances c2 command, 710
 edit routing-instances http command, 322
 edit schedulers best-effort command, 662
 edit so-0/1/0 unit command, 513
 EF (Expedited Forwarding), 624
 egress node in MPLS, 241
 election problems, PIM-SM RP, 449–450
 else term, 353
 enabling
 LDP instances, 132–134
 MPLS processing, 130–131
 RSVP signaling, 148–150
 Enhanced Flexible PIC Concentrators (E-FPCs), 620–621
 ERO constrained LSPs, 158
 configuring, 158–159
 verifying, 159–161
 EROs (Explicit Route Objects), 124, 141, 157, 706
 /etc/services file, 345
 EUI-64 (Extended Unique Identifier) format, 511–512
 eui-64 keyword, 512–513
 exact keyword for schedulers, 652, 657
 except option for prefix-specific counting, 316
 exclude statement in link coloring, 163
 exit command for RE firewall filters, 287
 EXP classification, 642
 exp-default table, 640
 expedited-fo queue counter, 630
 Expedited Forwarding (EF), 624

Explicit Route Objects (EROs), 124, 141, 157, 706
 export policies for IGP, 14–15
 exporting traffic sampling, 334–337
 ext-ipv6 peering, 542
 Extended Unique Identifier (EUI-64) format, 511–512
 extensive switch
 for DVMRP, 423
 for PIM dense mode, 436–437
 for schedulers, 656

F

families, address, 625
 Fast Reroute (FRR), 201–203, 202
 configuring, 203–204
 for CSPF, 163
 for MPLS, 236
 verifying, 204–205
 FBF (Filter Based Forwarding), 321–322
 configuring, 322–326
 filters for, 277
 summary, 329
 verifying, 326–328
 FCs (forwarding classes), 623–624
 FECs (forwarding equivalency classes), 134, 136
 FF (fixed filter) style
 for bandwidth reservation, 220
 for secondary paths, 198
 file show/etc/services command, 345
 Filter Based Forwarding (FBF), 321–322
 configuring, 322–326
 filters for, 277
 summary, 329
 verifying, 326–328
 filter_c1_routes term, 745
 filter-specific statement, 366
 firewall filters, 276–279, 278
 with address families, 625
 case study, 346–349, 346, 348
 analysis, 349–376
 configurations, 376–393
 Filter Based Forwarding, 321–322
 configuring, 322–326
 summary, 329
 verifying, 326–328
 policing, 307
 ICMP, 307–309
 LSP rate limiting, 309–313
 prefix-specific counting, 313–321
 for REs, 279
 applying and verifying, 286–299
 confirming initial operation, 279–280
 creating, 281–286
 review questions, 394–399
 review questions, answers to, 400–401
 summary, 321, 344–345
 transit filtering
 applying and verifying, 303–307
 creating, 299–303
 fixed filter (FF) style
 for bandwidth reservation, 220
 for secondary paths, 198
 Flexible PIC Concentrators (FPCs), 620–621
 flow records, 334–337
 flows in traffic sampling, 329
 Format Prefix (FP) with IPv6 addresses, 511–512
 forwarding
 Filter Based Forwarding (FBF), 321–322
 configuring, 322–326
 filters for, 277
 summary, 329
 verifying, 326–328
 LSP, 215–217
 forwarding-class action, 626–627
 forwarding classes (FCs), 623–624
 forwarding equivalency classes (FECs), 134, 136
 forwarding table export policies, 241
 FP (Format Prefix) with IPv6 addresses, 511–512
 FPCs (Flexible PIC Concentrators), 620–621
 FRR (Fast Reroute), 201–203, 202
 configuring, 203–204
 for CSPF, 163
 for MPLS, 236
 verifying, 204–205
 ftp command, 372–373
 ftp interface lo0 command, 319
 FTP sessions
 for firewall filters
 case study, 372–373
 prefix-specific counting, 319
 RE, 294–295
 port assignments for, 345

G

gateways, 139
 graceful-restart feature
 in LDP instance enabling, 132
 for MPLS, 246

H

help topic pim auto-rp command, 457
 hidden routes in EBGp, 34
 hold priority in preemption, 208
 hops, 78
 with EROs, 158
 in IBGP discovery, 23–24
 in IGP discovery, 16, 80
 for Layer 3 VPNs, 726–727
 in port mirroring, 339
 for routing table integration prefixes, 174
 HTTP service
 in firewall filter case study, 361
 port assignments for, 345

I

IBGP
 configuring, 546–558
 discovering and verifying, 20–24
 export policies, 241
 for IPv6 tunneling, 569–577
 verifying, 558–561
 ICMP policing
 configuring, 307–308
 verifying, 308–309
 icmp-sample file, 332–334
 icmp-type option, 281
 IGMP (Internet Group Management Protocol), 406, 406
 configuring, 407–408
 summary, 411
 verifying, 408–411
 IGP, 5–7, 6
 discovering
 case study, 67–82, 82
 core, 7–10
 redistribution, 10–19
 summary, 19–20, 20

OSPF
 configuring, 533–534
 troubleshooting, 538–540
 verifying, 534–537
 RIPng, 522, 523
 configuring, 523–529, 524–525
 verifying, 529–532
 verifying, 5
 core, 7–10
 redistribution, 10–19
 import statement, 644
 include statement, 163
 inet.3 tables
 for routing table integration, 172, 174
 for TE shortcuts, 183
 inet-unicast family, 548
 inet-vpn family, 721–722, 788, 800
 inet4 unicast family, 547
 inet6-unicast family, 548
 infinity metric, 412
 input filters, 277
 insert term bgp before term deny-all-else
 command, 292
 insert term la after term 1 command, 553
 insert term ospf-rsvp before term deny-all-else
 command, 292–293
 install action
 for routing table integration prefixes, 172
 for TE shortcuts, 179
 installing prefixes, 172–179, 173
 instance switch, 746
 int-vg peer group, 594
 interdomain multicast with MSDP
 configuring, 472–475, 473
 verifying, 475–479
 interface all option
 for draft-Martini VPNs, 767
 for MPLS, 231
 interface operation, verifying, 5
 interface-rib option, 413
 interface switch for prefix-specific
 counting, 319
 interfaces, troubleshooting, 341–342
 interfaces stanza
 for IS-IS baseline
 r1, 83–85
 r2, 87–88
 r3, 91–93
 r4, 97–99
 r5, 103–105

- r6, 107–108
- r7, 112–113
- for OSPF baseline
 - r1, 38–39
 - r2, 41–42
 - r3, 45–47
 - r4, 50–51
 - r5, 54–56
 - r6, 58–59
 - r7, 63–64
- Internet access from non-VRF interface, 764–766
- Internet Group Management Protocol (IGMP), 406, 406
 - configuring, 407–408
 - summary, 411
 - verifying, 408–411
- IP-IP tunnels, 561, 562
 - configuring, 562–567, 566
 - verifying, 567–569
- ipprec-compatibility classifier, 627
- IPv6, 510, 511
 - addresses, 510–513, 512
 - assigning, 513–515
 - and neighbor discovery, 522
 - verifying, 515–520
 - BGP support, 540–541, 541–542
 - case study, 578–579, 579–580
 - analysis, 580–597
 - configurations, 597–615
 - EBGP peering
 - configuring, 542–543
 - verifying, 543–546
 - IBGP peering
 - configuring, 546–558
 - verifying, 558–561
- OSPF
 - configuring, 533–534
 - troubleshooting, 538–540
 - verifying, 534–537
- review questions, 616–617
- review questions, answers to, 618
- RIPng, 522, 523
 - configuring, 523–529, 524–525
 - verifying, 529–532
- router advertisements
 - configuring, 515
 - verifying, 520–521
- summary, 577–578
- tunneling, 561, 562
 - configuring, 562–567, 566

- IBGP and EBGP adjustments for, 569–577
 - summary, 577
 - verifying, 567–569
- ipv6-agg policy, 545
- IS-IS routing protocol
 - adjacencies in, 5
 - baseline network, 82
 - r1, 82–86
 - r2, 86–90
 - r3, 90–96
 - r4, 96–102
 - r5, 102–106
 - r6, 106–111
 - r7, 111–116
 - case study, 67–82, 82
 - in CSPF, 162
 - default route, 594–595
 - for IGP discovery, 14
- isis-ospf policy, 17
- isis-rip policy, 75

J

- jncie-cos scheduler map, 652–655, 678–679

K

- keep-multiplier option, 245–246

L

- l1-l2 export policy, 72
- l2circuit for VPNs
 - case study, 784
 - draft-Martini, 768, 771
- lab logins, 4
- Label Distribution Protocol (LDP), 124
 - LDP signaled LSPs, 126
 - configuring, 126–130, 127
 - enabling LDP instances, 132–134
 - enabling MPLS processing, 130–131
 - summary, 141
 - verifying, 134–140
 - port assignments for, 345
- Label Switched Paths. *See* LSPs (Label Switched Paths)
- Label Switching Routers (LSRs), 124

- Layer 2 VPNs, 746–747
 - draft-Kompella, 747–750, 748
 - configuring, 750–755
 - verifying, 755–766
 - draft-Martini
 - configuring, 766–768
 - verifying, 769–773
 - Internet access from non-VRF interface, 764–766
 - mapping to LSPs, 760–764
 - summary, 773–774
 - Layer 3 VPNs, 699–700, 700
 - configuring
 - with BGP and static routing, 708–712, 709
 - with OSPF, 731–736
 - preliminary, 700–707, 701
 - with OSPF
 - configuring, 731–736
 - PE-CE, 727–731, 728
 - verifying, 736–739
 - redundancy and route filtering for, 739–746
 - summary, 746
 - troubleshooting, 714–715
 - verifying
 - with BGP and static routing, 712–727
 - with OSPF, 736–739
 - preliminary, 707–708
 - LDP (Label Distribution Protocol), 124
 - LDP signaled LSPs, 126
 - configuring, 126–130, 127
 - enabling LDP instances, 132–134
 - enabling MPLS processing, 130–131
 - summary, 141
 - verifying, 134–140
 - port assignments for, 345
 - ldp-stats file, 126
 - ldp-tunneling keyword, 232
 - Level 1 external routes, 14
 - limit-access term, 353
 - limit-http filter, 362–363
 - limit-icmp policer, 353
 - limit-mpls policy, 310–311
 - link coloring, 163–167, 163
 - link protection
 - configuring, 205–206
 - verifying, 206–208
 - Link State Databases (LSDBs), 179
 - lo0 interface in IGP discovery, 8
 - load merge command
 - for Filter Based Forwarding, 327
 - for VPN case study, 795
 - load override command, 562
 - loop detection, 159
 - loopback addresses
 - with EROs, 158
 - with IPv6 addresses, 512
 - loopback-based IBGP sessions, 21
 - loose EROs, 158
 - loss priority, 642
 - configuring, 642–646, 643
 - verifying, 646–650
 - LSDBs (Link State Databases), 179
 - LSP-Egress-to-OSPF-RID matches, 234
 - lsp-map policy
 - for LSP-to-prefix mapping, 189–192
 - for MPLS for OSPF baseline, 243–244
 - LSP-to-prefix mapping plans, 242
 - LSPs (Label Switched Paths), 124
 - ERO constrained
 - configuring, 158–159
 - verifying, 159–161
 - forwarding, 215–217
 - LDP signaled, 126
 - configuring, 126–130, 127
 - enabling LDP instances, 132–134
 - enabling MPLS processing, 130–131
 - summary, 141
 - verifying, 134–140
 - mapping Layer 2 VPNs to, 760–764
 - mapping prefixes to, 184–193
 - policing, 312–313
 - in preemption, 208
 - rate limiting, 309–312
 - stitching, 162
 - LSRs (Label Switching Routers), 124
-
- ## M
- mapping
 - in link coloring, 164
 - LSP-to-prefix, 242
 - to LSPs, 138
 - Layer 2 VPNs, 760–764
 - rules for, 138
 - for multicast case study, 483
 - prefixes, 184–193
 - mapping agents, Auto-RP, 456
 - mapping keyword, 483

- mapping policy, 762–763
- messages, Auto-RP, 456
- metrics
 - in DVMRP, 425–427
 - in LSP-to-prefix mapping, 188
- monitor interface command
 - for DVMRP, 421
 - for port mirroring, 340
- monitor start command
 - for CSPF troubleshooting, 170
 - for IGMP, 411
 - for MSDP interdomain, 476
 - for PIM
 - using bootstrap, 449–450
 - tracing, 463–464
 - for test-cflowd log file, 336
- monitor traffic command
 - for Filter Based Forwarding, 328
 - for transit firewall filters, 307
- monitor traffic interface command
 - for CoS
 - case study, 675–676
 - DSCP rewrites, 638–639, 641
 - loss priority, 649
 - for firewall filters
 - Filter Based Forwarding, 327–328
 - transit, 306
 - troubleshooting, 341
 - for IPv6 tunneling, 568–569
- MPLS (Multiple Protocol Label based Switching) and traffic engineering, 124–125, 125
 - case study, 223–226, 224–225
 - analysis, 226–247
 - configurations, 247–268
 - constrained routing in, 157–158
 - ERO constraints, 158–161
 - SPF constraints, 161–171, 163
 - LDP signaled LSPs for, 126
 - configuring, 126–130, 127
 - enabling LDP instances, 132–134
 - enabling MPLS processing, 130–131
 - summary, 141
 - verifying, 134–140
- miscellaneous capabilities and features, 214
 - bandwidth reservations, 220–223
 - LSP forwarding, 215–217
 - pop function, 217–220
- review questions, 269–271
- review questions, answers to, 272–273
- routing table integration, 172
 - installing prefixes, 172–179, 173
 - mapping prefixes, 184–193
 - summary, 193–194
 - traffic engineering shortcuts, 179–184
- RSVP signaled LSPs for, 141
 - configuring and verifying, 151–154
 - enabling RSVP signaling, 148–150
 - MPLS baseline support configuration, 141–148, 142
 - RSVP authentication configuration, 150–151
 - summary, 172
 - summary, 223
 - traffic protection in, 194
 - Fast Reroute in, 201–205, 202
 - link protection in, 205–208
 - preemption in, 208–214
 - secondary paths, 194–201
 - summary, 214
 - for VPNs, 698
- mpls family, 126
- MSDP (Multicast Source Discovery Protocol), 465
 - configuring
 - with Any-Cast, 465–470, 466
 - interdomain, 472–475, 473
 - summary, 479
 - verifying
 - with Any-Cast, 470–472
 - interdomain, 475–479
- Multi-Area OSPF topology, 234
- multicast, 404–405, 405
 - case study, 480–481, 481
 - analysis, 481–494, 482
 - configurations, 494–499
 - Distance Vector Multicast Routing Protocol, 412–413, 413
 - configuring, 413–416
 - summary, 429
 - tracing, 427–429
 - verifying, 416–427, 421
 - Internet Group Management Protocol, 406, 406
 - configuring, 407–408
 - summary, 411
 - verifying, 408–411
 - Multicast Source Discovery Protocol. *See* MSDP (Multicast Source Discovery Protocol)
 - PIM, 429–430. *See* PIM (Protocol Independent Multicast)
 - review questions, 500–504

- review questions, answers to, 505–507
- scoping for, 511
- summary, 480
- Multicast Source Discovery Protocol (MSDP), 465
 - configuring
 - with Any-Cast, 465–470, 466
 - interdomain, 472–475, 473
 - summary, 479
 - verifying
 - with Any-Cast, 470–472
 - interdomain, 475–479
- multifield classification, 624
 - configuring, 625–628
 - verifying, 628–631
- Multiple Protocol Label based Switching. *See* MPLS (Multiple Protocol Label based Switching) and traffic engineering

N

- NAT/PAT (Network Address/Port Address Translation) services, 276
- native EBGP peering
 - configuring, 542–543
 - verifying, 543–546
- NC (network control) traffic
 - forwarding, 624
 - schedulers for, 659–661
- neighbors
 - and IPv6 addresses, 512, 522
 - for LSP-to-prefix mapping, 190
- Network Address/Port Address Translation (NAT/PAT) services, 276
- network control (NC) traffic
 - forwarding, 624
 - schedulers for, 659–661
- network discovery and verification
 - case study
 - analysis, 67–82, 82
 - configurations, 82–116
 - EBGP routing policy, 24
 - customer peering in, 30–31
 - final checks, 34–35
 - P1 peering in, 24–27
 - r4 to C1 peering in, 32–34
 - r7 to C1 peering in, 31–32
 - summary, 35–36, 36
 - T1 peering in, 28–30
 - IBGP, 20–24
 - IGP, 5–7, 6
 - case study, 67–82, 82
 - core, 7–10
 - redistribution, 10–19
 - summary, 19–20, 20
 - OoB, 2
 - telnet for, 4–5
 - topology in, 3–4, 3
 - OSPF baseline network, 37
 - r1, 37–40
 - r2, 40–44
 - r3, 44–49
 - r4, 49–53
 - r5, 53–57
 - r6, 57–61
 - r7, 62–66
 - review questions, 117–120
 - review questions, answers to, 121–122
- Network Layer Reachability Information (NLRI), 540–541, 700
- next-hop option, 339
- next hops, 78
 - in IBGP discovery, 23–24
 - in IGP discovery, 16, 80
 - in port mirroring, 339
 - for routing table integration prefixes, 174
- next-term action for firewall filters
 - case study, 361
 - transit, 301
- nhs policy
 - for IBGP discovery, 22–23
 - for Internet access from non-VRF interface, 766
 - for IPv6
 - BGP, 550–552
 - case study, 594
 - tunneling, 570–571
- NLRI (Network Layer Reachability Information), 540–541, 700
- no-decrement-ttl option, 215
- no-ipv4-routing keyword, 583
- no-ipv6-routing keyword, 583
- no-propagate-ttl option, 215
- no-spoof option for firewall filters
 - case study, 359, 370
 - transit, 305
- non-VRF interface, Internet access from, 764–766
- NTP service port assignments, 345
- null labels, 218–219

O

OoB (Out Of Band) networks, 2
 telnet for, 4–5
 topology in, 3–4, 3

OSPF
 adjacencies in, 280
 baseline network, 37
 in MPLS and traffic engineering case study, 224–247, 224
 r1, 37–40
 r2, 40–44
 r3, 44–49
 r4, 49–53
 r5, 53–57
 r6, 57–61
 r7, 62–66
 configuring, 533–534
 port assignments for, 345
 troubleshooting, 538–540
 verifying, 534–537
 with VPNs, 727–731, 728
 configuring, 731–736
 PE-CE, 727–731, 728
 redundancy and route filtering, 739–746
 verifying, 736–739

ospf-isis policy, 15
 OSPF-to-BGP policy, 23
 ospf3-export policy, 533–534

Out Of Band (OoB) networks, 2
 telnet for, 4–5
 topology in, 3–4, 3

outgoing-tcp-services term, 353
 outgoing-udp-services term, 353
 output filters, 277

P

P1 router
 for EBGp discovery, 24–27
 for IPv6 case study, 595–597
 for MSDP interdomain, 478
 for prefix-specific counting, 317–320

packet classification in CoS, 623–624
 packet forwarding with RE filtering, 289
 packet loss priority (PLP), 636
 passwords for user accounts, 4

PAT (Port Address Translation) services, 276

PE-CE links
 BGP and static routing
 configuring, 708–712, 709
 verifying, 712–727
 with OSPF routing, 727–731, 728
 configuring, 731–736
 redundancy and route filtering, 739–746
 verifying, 736–739

PE (provider's edge) routers, 699

Penultimate Hop Popping (PHP), 124
 in LDP signaled LSP verification, 136
 for pop function, 217–218

PHB (per-hop behavior), 623

PIM (Protocol Independent Multicast), 429–430
 dense mode (PIM DM), 430–431
 configuring, 431–433
 verifying, 433–440
 sparse mode (PIM SM), 430, 441
 configuring using Auto-RP, 455–459, 455
 configuring using bootstrap, 441–445, 443
 RP election problems, 449–450
 verifying using Auto-RP, 459–463
 verifying using bootstrap, 445–455, 455
 summary, 464–465
 tracing, 463–464

pim-join policy, 486

ping command
 for CoS
 case study, 670–671
 DSCP rewrites, 640–641
 loss priority, 649–650
 multifield classification, 630–631
 schedulers, 657–658

for firewall filters
 case study, 360
 ICMP policing, 308–309
 LSP policing, 312–313
 port mirroring, 342
 prefix-specific counting, 320
 RE, 297
 traffic sampling, 333
 transit, 304–305

for IGMP, 408

for IPv6
 addresses, 518–519

- case study, 596–597
- EBGP, 544–546
- tunneling, 568, 571–576
- for LSPs
 - forwarding, 216–217
 - RSVP signaled, 156
- port assignments for, 345
- for static routing, 4
- for VPNs
 - with BGP and static routing, 712–713, 718–719
 - case study, 779, 806
 - draft-Kompella VPNs, 756
- PLP (packet loss priority), 636
- poison reverse, 412, 413
- police-icmp term, 353
- policing, 307
 - ICMP
 - configuring, 307–308
 - verifying, 308–309
 - LSP
 - rate limiting, 309–312
 - verifying, 312–313
 - prefix-specific counting
 - configuring, 313–316
 - verifying, 317–320
- policy-options stanza
 - for IS-IS baseline
 - r1, 86
 - r2, 89–90
 - r3, 94–96
 - r4, 100–102
 - r5, 106
 - r6, 110–111
 - r7, 115–116
 - for OSPF baseline
 - r1, 40
 - r2, 44
 - r3, 48–49
 - r4, 53
 - r6, 60–61
 - r7, 65–66
- pop function, 124, 217–220
- Port Address Translation (PAT) services, 276
- port mirroring, 338
 - configuring, 338–340, 338
 - in traffic sampling, 329
 - verifying, 340–343, 340, 342–343
- ports
 - assignments, 345
 - for firewall filters, 302, 307
 - for multifield classification, 626
 - preemption, 208–214
 - prefix-action for firewall filters
 - case study, 365–366, 369
 - prefix-specific counting, 314–315
 - Prefix Specific Counters and Policies (PSCP)
 - feature
 - configuring, 314–316
 - verifying, 317–320
 - prefix-specific counting
 - configuring, 313–316
 - verifying, 317–320
 - prefixes
 - LSP-to-prefix mapping plans, 242
 - mapping, 184–185
 - configuring, 185–191
 - verifying, 191–193
 - for routing table integration, 172–179, 173
 - primary keyword
 - for MPLS, 243–244
 - for MSDP, 467
 - priority
 - for Best Effort scheduler, 652
 - loss, 642
 - configuring, 642–646, 643
 - verifying, 646–650
 - in preemption, 208
- Protocol Independent Multicast (PIM), 429–430
 - dense mode (PIM DM), 430–431
 - configuring, 431–433
 - verifying, 433–440
 - sparse mode (PIM SM), 430, 441
 - configuring using Auto-RP, 455–459, 455
 - configuring using bootstrap, 441–445, 443
 - RP election problems, 449–450
 - verifying using Auto-RP, 459–463
 - verifying using bootstrap, 445–455, 455
 - summary, 464–465
 - tracing, 463–464
- protocol-port aggregation, 337
- protocols, port assignments for, 345
- protocols stanza
 - for IS-IS baseline
 - r1, 85–86
 - r2, 89
 - r3, 93–94

- r4, 99–100
- r5, 105–106
- r6, 109–110
- r7, 114–115
- for OSPF baseline
 - r1, 39–40
 - r2, 43–44
 - r3, 47–48
 - r4, 52–53
 - r5, 56–57
 - r6, 59–60
 - r7, 64–65
- provider's edge (PE) routers, 699
- prudent security philosophy, 279
- PSCP (Prefix Specific Counters and Policies)
 - feature
 - configuring, 314–316
 - verifying, 317–320

Q

- QoS (Quality of Service), 154
- quit command for firewalls
 - case study, 357
 - RE, 296

R

- r1 router
 - for IPv6
 - addresses, 518–519
 - case study, 584–585, 593, 598–600
 - IBGP, 548–557
 - RIPng, 526–528, 530
 - router advertisements, 515, 520–521
 - for MPLS
 - baseline support configuration, 142–145
 - LSP configuration and verification, 151–156
 - LSP forwarding, 217
 - OSPF, 232–233, 247–250
 - RSVP authentication configuration, 150–151
 - secondary paths, 195–199
 - for multicast
 - case study, 485, 494–495
 - DVMRP, 423
 - PIM DM, 435–436

- PIM SM using Auto-RP, 460
 - PIM SM using bootstrap, 443, 443, 445, 450–451
 - for network discovery and verification
 - EBGP, 24–27
 - IGP discovery, 9, 80–81
 - IS-IS, 82–86, 594
 - OSPF, 37–40
 - for VPN case study, 786–789, 792–793, 798–804, 807–809
- r2 router
 - for IPv6
 - case study, 587–589, 600–602
 - OSPF, 536–537
 - for MPLS
 - case study, 250–252
 - ERO constrained LSPs, 158–161
 - LSP forwarding, 215–216
 - for multicast
 - case study, 493–495
 - DVMRP, 424
 - MSDP, 470
 - PIM DM, 436–437
 - PIM SM using Auto-RP, 459, 463
 - PIM SM using bootstrap, 443, 443, 448–451
 - for network discovery and verification
 - IBGP discovery, 24
 - IGP discovery, 9–10, 71–72
 - IS-IS baseline, 86–90
 - OSPF, 40–44
 - for VPN case study, 795–797, 801–802, 809–812
- r3-lo0 filters, 286–299, 307–308
- r3 router
 - for CoS
 - case study, 672–678, 680–682
 - DSCP rewrites, 636–640
 - loss priority, 643–644, 646–647
 - multifield classification, 625–631
 - RED profiles, 661–663
 - schedulers, 651–653, 655
 - for firewall filters
 - case study, 349–351, 364–365, 376–380
 - ICMP policing, 307–309
 - prefix-specific counting configuring, 313–316
 - prefix-specific counting verifying, 317–320
 - RE, applying and verifying, 286–299

- RE, confirming initial operation, 279–280
- RE, creating, 281–286
- for IPv6
 - addresses, 517–520
 - case study, 581–583, 585–587, 591–594, 602–608
 - EBGP, 542–546
 - IBGP, 547–548, 550–554, 560
 - OSPF, 533–534, 538–540
 - RIPng, 524–526, 524–525, 529–531
 - tunneling, 563, 565–573, 576
- for MPLS
 - case study, 227–228, 235–237, 243–244, 252–257
 - Fast Reroute, 204–205
 - link coloring, 164–167
 - link protection, 206–208
 - RSVP authentication configuration, 151
 - RSVP signal enabling, 148–150
 - secondary paths, 200–202
- for multicast
 - case study, 483–484, 487, 490, 493, 495–497
 - DVMRP, 415–418, 420, 424–429
 - MSDP interdomain, 472–479, 473
 - MSDP with Any-Cast, 467–468, 470–471
 - PIM DM, 432, 435, 437–438
 - PIM SM using Auto-RP, 456, 458–462
 - PIM SM using bootstrap, 442–444, 443, 446, 453, 455
 - PIM tracing, 463–464
- for network discovery and verification
 - EBGP, 28–30
 - IGP discovery, 7–8, 15, 18–19, 67–71
 - IS-IS, 90–96
 - OSPF, 44–49
- for VPNs
 - case study, 786–787, 790–792, 794, 798–806, 812–815
 - draft-Martini, 768, 770
 - Layer 3, 707
- r4-C1 peering, 361
- r4-dscp-rewrite table, 672–674
- r4 router
 - for CoS
 - case study, 669–672, 674, 678, 683–686
 - DSCP rewrites, 641
 - loss priority, 645–650
 - multifield classification, 631–635
 - RED profiles, 663–666
 - schedulers, 654–655, 657–659
 - for firewall filters
 - case study, 358–363, 370–372, 380–384
 - Filter Based Forwarding, configuring, 322–326
 - Filter Based Forwarding, verifying, 326–327
 - traffic sampling, 333–334
 - transit, applying and verifying, 303–306
 - transit, creating, 299–303
 - for IPv6
 - addresses, 515–517
 - case study, 583–584, 589–591, 608–614
 - RIPng, 528–529, 531–532
 - tunneling, 563–564, 567–570, 573–576
 - for MPLS
 - bandwidth reservation, 220–223
 - baseline support configuration, 146–148
 - CSPF, constrained LSPs, 167–169
 - CSPF, troubleshooting, 169–171
 - Fast Reroute, 202–203
 - OSPF baseline, 238–240, 257–260
 - RSVP signaled LSP configuration and verification, 155–156
 - for multicast
 - case study, 483, 486–491, 494, 497–498
 - DVMRP, 418, 425–427
 - MSDP, 469–472
 - PIM DM, 431
 - PIM SM using Auto-RP, 456–457, 462–463
 - PIM SM using bootstrap, 443–444, 443, 447–448, 451–452
 - for network discovery and verification
 - EBGP, 32–34
 - IBGP, 23, 558–561
 - IGP, 8–9, 78
 - IS-IS baseline, 96–102
 - OSPF baseline, 49–53
 - for VPNs
 - with BGP and static routing, 711–717, 719, 725
 - case study, 778, 780–785, 815–817
 - draft-Kompella, 750–754, 757–758
 - draft-Martini, 766–769, 771–772
 - Internet access from non-VRF interface, 764–765
 - Layer 3, 706–708

- mapping to LSPs, 761–764
- with OSPF, 731, 734–738
- redundancy and route filtering, 744–745
- r4 to C1 peering, 32–34
- r4-voip-classifier filter, 669
- r5 router
 - for CoS
 - case study, 673–674, 679–680, 686–688
 - loss priority, 644–645
 - multifield classification, 634
 - network control traffic, 659–661
 - schedulers, 655–657
 - for firewall filters
 - case study, 351–358, 365–370, 372–375, 384–390
 - cflowd export, 335–337
 - Filter Based Forwarding, 327–328
 - ICMP policing, 308–309
 - LSP rate limiting, 310–313
 - port mirroring, 339–343
 - traffic sampling, 330–332
 - transit, 305–306
 - for IPv6
 - addresses, 513–514, 518
 - case study, 585, 589, 614–615
 - IBGP, 556–558
 - OSPF, 533–537
 - tunneling, 562
 - for MPLS
 - Fast Reroute, 202
 - LDP instance enabling, 133
 - LDP signaled LSP configuration, 126
 - LDP signaled LSP verification, 135–136
 - LSP forwarding, 216–217
 - OSPF, 228–231, 237–238, 245–247, 260–263
 - preemption, 209–214
 - processing enabling, 131
 - RSVP signaled LSP, 154
 - TE shortcuts, 181
 - for multicast
 - case study, 484, 489–490, 492–493, 499
 - DVMRP, 413–415, 418–422, 426
 - IGMP, 407–411
 - MSDP interdomain, 477–478
 - PIM DM, 431–434, 438–440
 - PIM SM using Auto-RP, 458–461
 - PIM SM using bootstrap, 445–447, 452–455
 - for network discovery and verification
 - EBGP, 34–35
 - IBGP, 20–21
 - IGP, 10–11, 72–73
 - IS-IS, 102–106
 - OSPF, 53–57
 - for VPNs
 - case study, 779–781, 817–818
 - draft-Martini, 768
 - Layer 3, 701–704
- r6-C2 peering, 361
- r6-r4-prime LSP, 762
- r6 router
 - in firewall filter case study, 355, 390–391
 - for MPLS
 - Fast Reroute, 203–204
 - LDP instance enabling, 134
 - LDP signaled LSP configuration, 127
 - LDP signaled LSP verification, 140
 - link protection, 205–207
 - OSPF, 234–235, 263–266
 - pop function, 218–220
 - routing table integration prefixes, 174–178
 - TE shortcuts, 179–184
 - for network discovery and verification
 - IGP, 11, 14–16, 76–77
 - IS-IS, 106–111
 - OSPF, 57–61
 - for VPNs
 - BGP and static routing, 710–712, 717, 722, 724
 - case study, 779, 781–782, 784, 818–819
 - draft-Kompella, 754–760
 - draft-Martini, 767–769, 771
 - mapping to LSPs, 761–763
 - OSPF, 731–735
 - redundancy and route filtering, 742–743
- r7-C1 peering, 31–32, 361
- r7 router
 - in firewall filter case study, 361, 392–393
 - for MPLS
 - LDP instance enabling, 132–133
 - LDP signaled LSP configuration, 127
 - LDP signaled LSP verification, 137–138
 - LSP-to-prefix mapping, 185–193
 - OSPF, 232–233, 242, 244, 266–268
 - processing enabling, 131
 - RSVP signaled LSP, 156–157
 - for network discovery and verification
 - EBGP, 31–32
 - IBGP, 22–23
 - IGP, 11–14, 17–18, 72–76

- IS-IS, 111–116
- OSPF, 62–66
- for VPNs
 - with BGP and static routing, 720–724
 - case study, 782–783, 819
 - Layer 3, 704–707
 - redundancy and route filtering, 739–741
- RADIUS/FTP server, 294
- RADIUS protocol
 - in firewall filter case study, 356–357
 - port assignments for, 345
- rate limiting, 309–312
- RE (routing engine) firewall filters, 276–277, 279
 - applying and verifying, 286–299
 - confirming initial operation, 279–280
 - creating, 281–286
- reachability in EBGp, 27, 34
- Record Route Object (RRO), 159–160
- RED profiles, 661
 - configuring, 661–664
 - verifying, 664–666
- RED related discards, 636
- redundancy for Layer 3 VPNs, 739–746
- register messages in PIM-SM, 430
- reject action
 - for firewall filters, 321
 - case study, 359
 - ICMP policing, 308
 - RE, 285
 - for IBGP, 554
- remainder keyword, 652
- rename interface command, 157
- rename term ssh to term ssh-ftp command, 284
- Rendezvous Points (RPs), 430, 441
- reservable bandwidth, 162
- Resolve Request counter, 487
- Resource Reservation Protocol. *See* RSVP (Resource Reservation Protocol)
- restart routing command, 539
- RESV (RSVP Path and Reservation) messages, 160
- Reverse Path Forwarding (RPF), 412
- rewrite markers for CoS, 635–636
 - DSCP rewrites
 - configuring, 636–639
 - verifying, 639–642
 - summary, 650–651
 - rewrite tables, 636–637, 640
 - rib-groups option, 323
 - rip-isis policy, 74
 - RIPng, 522, 523
 - configuring, 523–529, 524–525
 - verifying, 529–532
 - ripng-export policy, 527–528, 553, 557
 - rollback command
 - for PIM SM, 463
 - for schedulers, 659
 - for secondary paths, 201
 - root, 4
 - route-distinguisher-id statement, 711, 753
 - route filtering
 - for Layer 3 VPNs, 739–746
 - for MPLS, 241
 - route receive-protocol bgp command, 716
 - route redistribution, 534–537
 - route targets (RTs), 700
 - router access, telnet for, 3–4
 - router advertisements
 - configuring, 515
 - verifying, 520–521
 - routing engine (RE) firewall filters, 276–277, 279
 - applying and verifying, 286–299
 - confirming initial operation, 279–280
 - creating, 281–286
 - routing in reverse, 441
 - routing-instance stanza, 766
 - routing-instance switch, 746
 - routing-instances option, 329
 - routing-options in LDP instance enabling, 132
 - routing-options stanza
 - for IS-IS baseline
 - r1, 85
 - r2, 88–89
 - r3, 93
 - r4, 99
 - r5, 105
 - r6, 108–109
 - r7, 113–114
 - for OSPF baseline
 - r1, 39
 - r2, 43
 - r3, 47
 - r4, 51–52
 - r5, 56
 - r6, 59
 - r7, 64
 - routing table integration, 172
 - installing prefixes, 172–179, 173

- mapping prefixes, 184–193
- summary, 193–194
- traffic engineering shortcuts, 179–184
- RPF (Reverse Path Forwarding), 412
- RPs (Rendezvous Points), 430, 441
- RRO (Record Route Object), 159–160
- RSVP (Resource Reservation Protocol), 124
 - port assignments for, 345
 - summary, 172
 - troubleshooting, 154–157
- RSVP Path and Reservation (RESV)
 - messages, 160
- RSVP signaled LSPs, 141
 - configuring and verifying, 151–154
 - enabling RSVP signaling, 148–150
 - MPLS configuration, 141–148, 142
 - RSVP authentication configuration, 150–151
- RTs (route targets), 700
- run-length parameter, 330

S

- sample action
 - in firewall filter case study, 374–376
 - for traffic sampling, 331
- sample-icmp filter, 331–332
- sampling traffic. *See* traffic sampling
- scheduler-map, 651–652
- schedulers, 651
 - configuring, 651–655
 - summary, 666
 - verifying, 655–659
- scoping for addresses, 511
- SE (Shared Explicit) reservation style, 198
- secondary lo0 addresses, 241
- secondary paths in traffic protection, 194–201
- security, firewall filters for. *See* firewall filters
- Serial Line Address Resolution Protocol (SLARP) protocol traffic, 341
- services, port assignments for, 345
- Session Object attributes, 200
- set address command, 343
- set admin-groups command, 164
- set aggregate route command, 545
- set area 0 interface command, 533
- set area 2 command, 15
- set at-0/1/0 scheduler-map command, 653
 - for rewrite rules, 644
 - for schedulers, 653
- set at-0/2/1 command
 - for firewall filters, 332
 - for Layer 3 VPNs, 701
- set auto-bandwidth command
 - for adjust interval, 222
 - for minimum bandwidth, 220
- set be-low-plp fill-level command, 661–662
- set best-effort command, 662
- set buffer-size percent command, 652, 657
- set community c1-c2-rt members target command, 753
- set community c1-c2-vpn members target command, 732
- set count command, 314
- set dense-groups command, 457
- set destination-prefix-length command, 315
- set drop-profile-map loss-priority command, 662
- set encapsulation command
 - for traffic sampling, 339
 - for VPNs, 751
- set external-preference command, 743
- set family command
 - for BGP, 547
 - for IPv6 addresses, 513
- set fe-0/0/0 unit command
 - for MPLS
 - baseline support configuration, 143
 - LDP signaled LSP configuration, 126
 - for traffic sampling, 332
 - for VPNs, 701
- set fe-0/0/3 unit command, 407
- set forwarding-class best-effort loss-priority command, 643–645
- set forwarding-table export command
 - for LSP-to-prefix mapping, 191
 - for VPN to LSP mapping, 763
- set group command
 - for IGP, 526
 - for MSDP, 467, 474
- set import default command, 643–645
- set instance-type command
 - for Filter Based Forwarding, 322
 - for VPNs
 - draft-Kompella, 752
 - VRF routing, 710
- set interface all command, 414
 - for DVMRP, 414
 - for PIM, 456
- set interface at command, 164

- set interface fe-0/0/0 command
 - for draft-Kompella VPNs, 752
 - for multicast case study, 487
 - for router advertisements, 515
- set interface fe-0/0/1 command, 150
- set interface fe-0/0/3 command, 407
- set interface fe-0/1/3 command, 710
- set interface fxp0 disable command, 415
- set interface lo0 command, 767
- set interface-routes rib-group inet command
 - for DVMRP, 413
 - for Filter Based Forwarding, 323
- set interface so-0/1/0.100 command, 767
- set interface so-0/2/0.100 command
 - for link coloring, 164
 - for link protection, 206
- set interface vt-0/3/0 command, 804–805
- set interfaces at-0/2/1 command, 645
- set interfaces fe-0/0/2 command, 801
- set jnic-cos forwarding-class command, 653
- set label-switched-path command
 - for active prefixes, 177
 - for Fast Reroute, 203
 - for Layer 3 VPNs, 706
 - for link coloring, 168
 - for link protection, 205
 - for LSPs
 - CSPF constrained, 167
 - ERO constrained, 159
 - LSP-to-prefix mapping, 185–186
 - RSVP signaled, 151, 153
 - for preemption, 209, 212
 - for routing table integration prefixes, 174, 176
 - for secondary paths, 195–196, 198–199
 - for TE shortcuts, 180
- set lo0 unit 0 family command
 - for IBGP, 552
 - for LSP forwarding, 217
 - for MSDP, 467
 - for RE firewall filters, 286
- set local-address command, 472
- set maximum-routes command, 733–734
- set mpls label-switched-path command, 215
- set neighbor command
 - for draft-Martini VPNs, 768
 - for EBGP, 542
 - for IPv6 tunneling, 563
- set no-keepalives command, 341
- set output cflowd command, 335–336
- set output port-mirroring interface
 - command, 339
- set path command
 - for Fast Reroute, 203
 - for LSP-to-prefix mapping, 185–186
 - for preemption, 209
 - for routing table integration prefixes, 174
 - for secondary paths, 195–196
- set peer-as command, 542
- set pim interface command
 - for PIM DM, 432
 - for PIM SM, 444
- set pim rp local address command, 444
- set policer be-policer command, 626
- set policer dc command, 314
- set policer icmp command, 307
- set policer limit-mpls command, 310
- set priority low command, 652
- set protocols bgp group command
 - for IPv6, 545
 - for VPNs, 794
- set protocols l2vpn command, 752
- set protocols ldp explicit-null command, 218
- set protocols ldp interface command
 - for LDP instance enabling, 132
 - for VPN case study, 801
- set protocols ldp keepalive-interval
 - command, 132
- set protocols ldp traffic-statistics
 - command, 132
- set protocols mpls explicit-null
 - command, 218
- set protocols mpls interface all command
 - for Layer 3 VPNs, 702
 - for MPLS
 - baseline support configuration, 143
 - processing enabling, 131
- set protocols mpls interface fe-0/0/2
 - command, 801
- set protocols mpls traffic-engineering
 - command, 182
- set protocols ospf traffic-engineering
 - command, 162
- set protocols ospf3 area 0 interface
 - command, 573
- set protocols rsvp interface at-0/1/0
 - command, 149
- set protocols rsvp interface fe-0/0/0 command
 - for authentication configuration, 151
 - for signal enabling, 148

- set protocols rsvp interface so-0/2/0.100
 - command, 149
- set query-response-interval command, 407
- set rib-group command, 415
- set rib-groups command
 - for DVMRP, 414
 - for Filter Based Forwarding, 323
- set rib inet6.0 static route command, 526
- set route command, 724
- set route-distinguisher-id command, 711
- set routing-options command
 - for Filter Based Forwarding, 322
 - for IPv6, 539–540
 - for Layer 3 VPNs, 711
 - for LDP restarts, 132
- set rp auto-rp mapping command, 457
- set rp local address command, 467
- set rsvp interface command, 702
- set sampling input family command, 330
- set sampling output file command, 330
- set scope announce interface command, 474
- set so-0/1/0 unit command
 - for Layer 3 VPNs, 701
 - for traffic sampling, 332
- set so-0/2/0 unit command, 644
- set static route command
 - for Internet access from non-VRF interface, 764
 - for Layer 3 VPNs, 718
- set statistics auto-bandwidth command, 220
- set statistics file command, 220
- set subnet-prefix-length command, 315
- set term 1 from destination-address command, 315
- set term 1 from neighbor command, 189
- set term 1 from protocol command
 - for firewall filters
 - prefix-specific counting, 315
 - traffic sampling, 331
 - transit, 300
 - for LSP-to-prefix mapping, 189
 - for RIPng, 527
- set term 1 from route filter command, 189
- set term 1 from source-address command, 315
- set term 1 from tcp-initial command, 299
- set term 1 then accept command
 - for LSP-to-prefix mapping, 189
 - for RIPng, 527
 - for traffic sampling, 331
- set term 1 then count c1-syns command, 300
- set term 1 then install-nexthop command, 189
- set term 1 then next term command, 300
- set term 1 then prefix-action command, 315
- set term 1 then sample command, 331
- set term 1k-icmp command, 301
- set term 2 from protocol static command, 527
- set term 2 from route-filter command, 527
- set term 2 from source-address command, 300
- set term 2 then accept command
 - for prefix-specific counting, 316
 - for RIPng, 527
 - for transit firewall filters, 300
- set term 3 from protocol direct command, 527
- set term 3 from route-filter command for IPv6
 - IBGP, 553
 - RIPng, 527
- set term 3 then accept command, 527
- set term accept-all then accept command, 302–303
- set term be then policer be-policer command, 626
- set term bgp command, 290
- set term deny-all-else command, 284–285
- set term icmp command, 281
- set term la from route-filter command, 553
- set term no-spoof command, 301
- set term ospf-rsvp ospf command, 290
- set term rtp command, 626
- set term sip command, 625
- set term ssh command, 283
- set term ssh-ftp command, 284
- set term telnet-in command, 282
- set term telnet-out command, 282
- set then policer icmp command, 308
- set traceoptions file command, 336
- set traffic-engineering shortcuts command, 181
- set transmit-rate percent 1 command, 657
- set transmit-rate percent 10 command, 651
- set type external command
 - for EBGp, 542
 - for IPv6 tunneling, 563
- set unit 0 classifiers command, 633
- set unit 0 family inet address command, 339
- set unit 0 family inet filter input command
 - for prefix-specific counting, 316
 - for transit firewall filters, 303
- set unit 0 family inet filter output command, 303

- set unit 0 family inet6 address command
 - for IPv6
 - EBGP, 543
 - tunneling, 563, 567
- set unit 0 family mpls policer input command, 311
- set unit 0 rewrite-rules command, 638
- set unit 0 tunnel command, 567
- set unit 0 vlan-id command, 751
- set unit 100 classifiers command, 633
- set unit 600 encapsulation command, 751
- set vlan-tagging command, 751
- set vrf-export c1-c2-export command, 752
- set vrf-import c1-c2-import command, 752
- set vrf-target target command, 710–711
- setup priority in preemption, 208
- Shared Explicit (SE) reservation style, 198
- Shortest Path First (SPF), 161–163
 - link coloring for, 163–167, 163
 - for LSPs, 167–169
 - for RSVP signaled LSPs, 152–154
 - and TEDs, 158
 - troubleshooting, 169–171
- shortest path trees, 430
- show command
 - for CoS
 - case study, 669–670
 - DSCP rewrites, 639
 - loss priority, 644–646
 - multifield classification, 633–634
 - network control traffic, 659–661
 - RED profiles, 662–664
 - schedulers, 652, 657
 - for firewall filters
 - case study, 358–359
 - cflowd export, 336
 - Filter Based Forwarding, 322–324
 - ICMP policing, 308
 - LSP rate limiting, 311–312
 - port mirroring, 339–340, 343
 - RE, 285–286, 290–291
 - traffic sampling, 331
 - transit, 302–303
 - for IGP discovery, 71–72
 - for IPv6
 - EBGP, 542–543
 - IBGP, 547–548, 551, 553–555, 558
 - OSPF, 533
 - RIPng, 526–528
 - router advertisements, 515, 521
 - for MPLS
 - bandwidth reservation, 220–221
 - Fast Reroute, 203–204
 - link protection, 205–206
 - LSP-to-prefix mapping, 185–186, 190–191
 - OSPF, 236, 238–239
 - preemption, 209–210, 212–213
 - secondary paths, 195–197
 - for multicast
 - case study, 483, 487, 489, 493–494
 - DVMRP, 414–415
 - IGMP, 407, 410–411
 - MSDP, 473–474
 - PIM DM, 431–432, 439
 - PIM SM using Auto-RP, 457–459
 - PIM SM using bootstrap, 444–445
 - for VPNs
 - with BGP and static routing, 711
 - case study, 778, 783–784, 787–788, 790–791, 795, 800–801
 - draft-Kompella, 751–753
 - draft-Martini, 767–768
 - Layer 3, 706–707
 - mapping to LSPs, 761
 - with OSPF, 731–733
 - show arp command, 408–409
 - show be-high-plp command, 662
 - show bgp neighbor command
 - for EBGP, 24–25
 - for firewall filters, 360–361
 - for IPv6
 - case study, 586–587
 - EBGP, 546
 - IBGP, 547–549
 - tunneling, 564
 - for VPNs
 - with BGP and static routing, 714–715
 - case study, 791
 - draft-Kompella, 758
 - show bgp summary command
 - for EBGP, 28, 31
 - for firewall filters
 - case study, 350, 358, 363
 - RE, 280, 288–289, 293–294
 - for IBGP, 21
 - for IPv6
 - case study, 588–590
 - EBGP, 543–544
 - IBGP, 558–559

- for MPLS, 227
- for VPNs
 - with BGP and static routing, 713, 717, 722
 - case study, 789, 791
 - draft-Kompella, 757
- show chassis fpc pic-status command
 - for IPv6 tunneling, 566
 - for PIM SM, 442
 - for TS PIC, 404
 - for VPN case study, 804
- show chassis hardware command
 - for E-FPV, 620–621
 - for IP II, 276
- show class-of-service command for
 - CoS case study
 - r3, 680–682
 - r4, 683–685
 - r5, 686–688
- show class-of-service classifier command for
 - CoS, 635
 - case study, 674–675
 - loss priority, 647
 - multifield classification, 627–628
- show class-of-service drop-profile command, 664–666
- show class-of-service forwarding-class command, 629, 635
- show class-of-service forwarding-table command, 656
- show class-of-service interface at-0/1/0 command for CoS
 - case study, 675
 - DSCP rewrites, 640
 - loss priority, 647
 - schedulers, 655
- show class-of-service interface at-0/2/1 command, 679–680
- show class-of-service interface fe-0/0/2 command, 627
- show class-of-service interface so-0/1/0 command for CoS
 - case study, 674, 678
 - loss priority, 647–648
 - multifield classification, 634
- show class-of-service interface so-0/1/1 command, 648
- show class-of-service interface so-0/2/0 command for CoS
 - DSCP rewrites, 640
 - loss priority, 647
 - schedulers, 655
- show class-of-service rewrite-rule command
 - for CoS
 - case study, 674
 - DSCP rewrites, 636
 - loss priority, 646
 - schedulers, 651
- show class-of-service scheduler-map command for CoS
 - CoS case study, 679
 - RED profiles, 665
 - schedulers, 655–656
- show class-of-service schedulers best-effort command, 659
- show classifier command, 631
- show classifiers command, 672
- show community c1 command, 744
- show community domain command, 733
- show dvmrp neighbors command, 418
- show dvmrp prunes command, 425, 427
- show expedited-forwarding command, 652–655
- show family inet command for firewall filters
 - case study, 365–366
 - prefix-specific counting, 315
- show fe0/0/3 command, 407
- show filter classify command, 626–627
- show filter dc-pscp command, 367
- show firewall command
 - for CoS
 - multifield classification, 631
 - r3, 682–683
 - r4, 685–686
 - for firewall filters, 351, 361
 - r3, 378–379
 - r4, 382–383
 - r5, 386–389
 - r6, 391
 - r7, 393
 - transit, 303
 - for VPN case study, 805–806, 814–815
- show firewall filter command
 - for DVMRP, 422
 - for firewall filters
 - case study, 361–362, 370–371, 374
 - Filter Based Forwarding, 325–326
 - ICMP policing, 309
 - RE, 297

- show firewall log command
 - for firewall filter case study, 354–355
 - for RE firewall filters, 288, 295–296, 298
- show firewall policer command, 361, 363–364
- show firewall prefix-action-stats command
 - for firewall filter case study, 369, 373–374
 - for prefix-specific counting, 317–318, 320
- show forwarding options command, 374–375, 389–390
- show fxp0 command, 332
- show igmp group command, 409
- show igmp interface command, 409
- show igmp statistics command, 410
- show interfaces command
 - for CoS case study
 - r3, 673, 677–678
 - r4, 672
 - for firewall filters, 359, 362
 - r3, 376–388
 - r4, 380–381
 - r5, 384–386
 - r6, 390–391
 - r7, 392–393
 - traffic sampling, 331
 - for IGP discovery, 11–13
 - for MPLS, 228–230
 - baseline support configuration, 143–144, 146
 - LDP signaled LSP configuration, 127–129
 - r1, 247–248
 - r2, 250–251
 - r3, 252–254
 - r4, 257–258
 - r5, 260–261
 - r6, 263–264
 - r7, 266–267
 - for OSPF, 538
 - for VPNs
 - draft-Kompella, 748–749
 - Layer 3, 702–706
 - with OSPF, 729
- show interfaces at-0/1/0 command for IPv6
 - addresses, 517–518
 - case study, 582, 603–604
- show interfaces at-0/2/1 command
 - for DVMRP, 422
 - for IPv6
 - addresses, 514
 - case study, 614
 - for loss priority, 645
- show interfaces fe-0/0/0 command
 - for CoS
 - case study, 670, 686
 - DSCP rewrites, 637, 641
 - schedulers, 658
 - for firewall filter case study, 368
 - for IPv6
 - case study, 581
 - r1, 598
 - r2, 587, 600
 - r3, 602–603
 - r4, 608
 - RIPng, 529
 - tunneling, 563
 - for VPN case study, 779–780, 786
 - r3, 812
 - r4, 815–816
 - r5, 817
- show interfaces fe-0/0/1 command
 - for IPv6, 581–582
 - addresses, 518–519
 - case study, 594
 - r1, 598
 - r2, 600–601
 - r3, 603
 - r4, 608–609
 - RIPng, 530
 - for VPN case study, 786
 - r1, 807
 - r3, 812
 - r5, 817
- show interfaces fe-0/0/2 command
 - for CoS
 - case study, 678, 683
 - multifield classification, 628
 - for firewall filter case study, 364–365
 - for IPv6, 585
 - EBGP, 543
 - r1, 598–599
 - r2, 602
 - r3, 603
 - r4, 609
 - for VPN case study, 806
 - r1, 807
 - r2, 809
 - r3, 812
- show interfaces fe-0/0/3 command
 - for firewall filter case study, 375
 - for IPv6 case study
 - r1, 599
 - r2, 602

- for multicast
 - case study, 489, 499
 - IGMP, 408
- for VPN case study
 - r2, 809–810
 - r4, 816
- show interfaces fe-0/1/0 command, 779, 818
- show interfaces fe-0/1/3 command for VPNs
 - case study, 818
 - draft-Kompella, 755
- show interfaces fe-0/3/1 command, 782, 819
- show interfaces fe-0/3/3 command, 783, 819
- show interfaces fxp0 command, 517
- show interfaces ip-0/3/0 command, 567–568, 571–572
- show interfaces lo0 command
 - for firewall filter case study, 354
 - for IGP discovery, 69–70, 73
 - for IPv6, 583
 - addresses, 514
 - IBGP, 556
 - r1, 599
 - r3, 604
 - r4, 610
 - r5, 615
 - for MPLS, 243
 - for MSDP, 468–470
 - for VPN case study, 798–799
 - r1, 807
 - r2, 810
 - r3, 812–813
- show interfaces ospf command, 572
- show interfaces policers command, 313
- show interfaces queue command, 658–659
- show interfaces so-0/1/0 command
 - for CoS
 - case study, 671, 673–674
 - network control traffic, 661
 - schedulers, 656–657
 - for DVMRP, 422
 - for firewall filter case study, 375
 - for IPv6
 - addresses, 513–514, 517
 - r4, 609
 - r5, 614–615
 - for VPN case study, 779, 817
- show interfaces so-0/1/1 command
 - for IPv6 case study, 609–610
 - for VPN case study, 816
- show interfaces so-0/2/0 command
 - for IPv6 case study, 582, 604
 - for multifield classification, 629–630
- show interfaces terse command
 - for IPv6 addresses, 515–516
 - for MPLS
 - LDP signaled LSP configuration, 129–130
 - LSP forwarding, 217
- show interfaces vt-0/3/0 command, 805, 812
- show ipv6 neighbors command, 519
- show ipv6 router-advertisement command, 520–521
- show isis adjacency command
 - for firewall filter case study, 349
 - for IGP discovery, 14, 73
 - r2, 71
 - r3, 70
 - r7, 76
- show isis database command, 179–180
- show isis hostname command, 70
- show isis interface command
 - r3, 69
 - r5, 73
- show l2circuit connections command
 - for VPNs
 - case study, 784
 - draft-Martini, 771–772
- show l2vpn connections command, 756, 758
- show ldp database command for MPLS
 - LDP signaled LSP verification, 136
 - OSPF baseline, 233
 - pop function, 218–219
- show ldp interface command, 133
- show ldp neighbor command
 - for MPLS
 - LDP instance enabling, 133
 - LDP signaled LSP verification, 135
 - OSPF, 233
 - for VPNs
 - case study, 781, 784
 - draft-Martini, 769
- show ldp session command
 - for MPLS
 - LDP instance enabling, 133
 - LDP signaled LSP verification, 135
 - OSPF, 233
 - for VPN case study, 781
- show ldp traffic-statistics command, 140
- show lo0 command, 286–287

854 show log command – show pim rps command

- show log command, 332–334
- show log access-log command, 356
- show log isis command, 5
- show log ldp-stats command, 140
- show mpls interface command
 - for MPLS
 - baseline support configuration, 145, 148
 - LDP signaled LSP configuration, 129
 - link coloring, 165
 - for OSPF baseline, 231
 - processing enabling, 131
 - for VPNs
 - case study, 780
 - Layer 3, 707
- show mpls lsp command
 - for bandwidth reservation, 221–222
 - for CSPF troubleshooting, 169–170
 - for ERO constrained LSPs, 159–160
 - for LDP signaled LSP verification, 138
 - for link coloring, 168–169
 - for OSPF, 239
 - for preemption, 210–214
 - for routing table integration prefixes, 174
 - for RSVP signaled LSPs, 152
 - for secondary paths, 195–196, 198–200
- show msdp command, 490–491
- show msdp peer command, 470
- show msdp source-active command for multicast
 - case study, 490–491
 - for MSDP
 - with Any-Cast, 471
 - interdomain, 476–477
- show multicast next-hops command
 - for case study, 491–493
 - for DVMRP, 424–425, 427
 - for PIM DM, 436
- show multicast route command
 - for case study, 491–492
 - for DVMRP, 420–427
 - for MSDP interdomain, 477–478
 - for PIM DM, 435–438
 - for PIM SM, 450–451
- show multicast rpf command
 - for PIM DM, 434, 440
 - for PIM SM, 446–447
- show multicast scope command
 - for case study, 487–488
 - for MSDP interdomain, 479
- show ospf database command
 - for IGP discovery, 9
 - for VPNs
 - with OSPF, 730, 737–738
 - redundancy and route filtering, 741, 744–745
- show ospf neighbor command, 8
 - for IGP discovery, 9, 11, 14
 - for MPLS for OSPF baseline, 227
 - for RE firewall filters, 279, 288, 293
 - for VPNs
 - draft-Kompella, 760
 - draft-Martini, 772
 - with OSPF, 736
- show ospf3 database command, 535–536, 539
- show ospf3 interface command, 539
- show ospf3 neighbor command
 - for IPv6 tunneling, 573, 576
 - for OSPF, 534, 539–540
- show output command, 335
- show pim command
 - for PIM DM, 432
 - for PIM SM, 444
- show pim bootstrap command, 447
- show pim interfaces command
 - for case study, 484
 - for PIM DM, 433, 435
 - for PIM SM
 - using Auto-RP, 459
 - using bootstrap, 446
- show pim join command
 - for case study, 488–492, 494
 - for MSDP
 - with Any-Cast, 471–472
 - interdomain, 477
 - for PIM DM, 436–440
 - for PIM SM, 460–461
 - using Auto-RP, 461–462
 - using bootstrap, 450–454
- show pim neighbors command
 - for multicast case study, 484
 - for PIM DM, 433–434
 - for PIM SM, 446
- show pim rps command
 - for case study, 484–485
 - for MSDP
 - with Any-Cast, 470
 - interdomain, 478
 - for PIM DM, 435
 - for PIM SM
 - using Auto-RP, 460, 463
 - using bootstrap, 447–448, 454

- show policer command
 - for firewall filter case study, 364–365
 - for LSP policing, 313
- show policer be-policer command, 627
- show policer dc command, 314
- show policer ftp command, 366
- show policer http command, 366–367
- show policer icmp command, 308
- show policer limit-mpls command, 310
- show policy-options command
 - for MPLS
 - r3, 255–257
 - r5, 262–263
 - r6, 265–266
 - for VPNs
 - draft-Kompella, 749–750
 - Layer 3, 729
- show policy-options community c1-c2-rt command, 754
- show policy-options community c1-c2-vpn command, 735
- show policy-options community domain command for VPNs
 - with OSPF, 735
 - redundancy and route filtering, 740
- show policy-options community vpn-c1-c2 command, 740
- show policy-options policy-statement command
 - for IPv6
 - case study, 583, 592–593
 - EBGP, 545
 - IBGP, 550–551, 557
 - OSPF, 534
 - RIPng, 528–529
 - for MPLS, 243
 - for multicast
 - DVMRP, 425–426
 - r3, 497
 - r4, 493, 498
 - for network discovery and verification
 - EBGP, 26, 545
 - IBGP, 22, 550–551, 557
 - IGP discovery, 78–80
- show policy-options policy-statement bgp-ospf command for VPNs
 - with OSPF, 738
 - redundancy and route filtering, 741
- show policy-options policy-statement c1-c2-export command, 755
- show policy-options policy-statement c1-c2-import command, 754–755
- show policy-options policy-statement c1-export command for VPNs
 - with OSPF, 735
 - redundancy and route filtering, 740
- show policy-options policy-statement ebgp-in command, 29
- show policy-options policy-statement ebgp-out command
 - for EBGp discovery, 29, 32–33
 - for IPv6 case study, r4, 612
- show policy-options policy-statement ipv6-agg command, 560
- show policy-options policy-statement isis-ospf command, 17
- show policy-options policy-statement l1-l2 command, 72
- show policy-options policy-statement nhs command, 764–765
- show policy-options policy-statement ospf-isis command, 14–15
- show policy-options policy-statement r1-v6 command, 607–608
- show policy-options policy-statement r2-v6 command, 608
- show policy-options policy-statement rip-isis command, 75
- show policy-options policy-statement send-lo0 command, 802, 814
- show policy-options policy-statement static-rip command, 75
- show policy-options policy-statement v6-default command for IPv6 case study
 - r3, 607
 - r4, 612–613
- show policy-statement bgp-ospf command, 745
- show policy-statement c1-c2-export command, 753–754
- show policy-statement c1-c2-import command, 753
- show policy-statement c1-export command, 744
- show policy-statement mapping command, 762

- show policy-statement pim-join
 - command, 486
- show protocols command
 - for IGP discovery, 7, 13–14
 - r3, 67–70
 - r7, 73–74
 - for MPLS, 230–231
 - baseline support configuration, 144–145
 - r1, 248–250
 - r2, 251–252
 - r3, 254–255
 - r4, 259–260
 - r5, 261–262
 - r6, 264–265
 - r7, 267–268
 - for VPNs
 - draft-Kompella, 749
 - with OSPF, 729
 - r1, 807–808
 - r2, 810–811
 - r3, 813–814
- show protocols bgp command
 - for IPv6, 589, 591–592
 - case study, 585–588
 - IBGP, 556–557
 - r1, 599–600
 - r2, 602
 - r3, 605–606
 - r4, 611–612
 - r5, 615
 - tunneling, 563–564, 569
 - for MPLS, 244
 - for network discovery and verification
 - EBGP, 25–26, 28, 31–33
 - IBGP, 20–23
 - IGP, 78
 - for VPNs
 - with BGP and static routing, 722
 - case study, 788–789
 - draft-Kompella, 757
 - Layer 3, 721
- show protocols dvmrp command, 416, 426
- show protocols igmp command for multicast
 - case study
 - r4, 498
 - r5, 499
- show protocols isis command
 - for IGP discovery, 71
 - for IPv6 case study, 584
 - r3, 606–607
 - r4, 612
- show protocols l2circuit command for VPN
 - case study
 - r4, 817
 - r6, 819
- show protocols ldp command
 - for MPLS
 - LDP instance enabling, 132–134
 - OSPF, 232
 - pop function, 219
 - for VPNs, 780, 783, 786–787
 - draft-Martini, 768
 - r4, 816
 - r5, 818
 - r6, 818
 - r7, 819
- show protocols mpls command
 - for MPLS
 - active prefixes, 177–178
 - baseline support configuration, 146–148
 - MPLS processing enabling, 131
 - OSPF, 232, 234
 - pop function, 219
 - TE shortcuts, 182
 - for VPNs, 779–780, 783, 786–787
 - Layer 3, 702, 704
 - r4, 816
 - r5, 817–818
 - r6, 818
 - r7, 819
- show protocols msdp command for multicast
 - case study, 490, 493
 - r3, 496
 - r4, 498
 - MSDP, 467–469
 - with Any-Cast, 467–469
 - interdomain, 475–476
- show protocols ospf command
 - for IGP, 9–10
 - for MPLS, 236–237
- show protocols ospf3 command, 533, 538–539
- show protocols pim command
 - for MSDP
 - with Any-Cast, 468–469
 - interdomain, 478–479
 - for multicast case study, 485, 493
 - r1, 494–495
 - r2, 495
 - r3, 495–497
 - r4, 497–498
 - r5, 499

- for PIM DM, 433
- for PIM SM
 - using Auto-RP, 458–460
 - using bootstrap, 445, 449
- show protocols ripng command, 528
- show protocols rsvp command
 - for Layer 3 VPNs, 702, 704
 - for MPLS
 - OSPF, 235, 245–246
 - RSVP signal enabling, 149
 - RSVP signaled LSPs, 155–156
- show rewrite-rules command, 671–672
- show ripng neighbor command, 529
- show route command
 - for firewall filters
 - case study, 350–351
 - Filter Based Forwarding, 326–327
 - for IPv6
 - case study, 588–591
 - IBGP, 549, 551, 554–556, 558
 - IS-IS default route, 594
 - OSPF, 535–537
 - RIPng, 524–526
 - tunneling, 564–565, 570–571, 573–576
 - for MPLS
 - active prefixes, 178
 - ERO constrained LSPs, 161
 - LDP signaled LSP verification, 137–139
 - OSPF, 228
 - routing table integration prefixes, 175–176
 - TE shortcuts, 183–184
 - for multicast
 - DVMRP, 419–420, 426
 - PIM DM, 434, 439–440
 - for network discovery and verification
 - IBGP, 24
 - IGP, 10–11, 16–19, 76–77, 80
 - for VPNs
 - with BGP and static routing, 723–724
 - case study, 782
 - draft-Martini, 769–770
 - Internet access from non-VRF
 - interface, 764–765
 - with OSPF, 737, 739
 - redundancy and route filtering, 742–743
- show route advertising-protocol bgp command
 - for EBGP, 26–27, 30, 33–34, 545
 - for IGP, 80
 - for PIM DMs, 433
 - for PIM SM
 - using Auto-RP, 458–460
 - using bootstrap, 445, 449
 - for VPNs
 - with BGP and static routing, 716–717
 - case study, 792–793, 802
 - draft-Kompella, 759
- show route advertising-protocol dvmrp command, 420
- show route advertising-protocol ripng command, 529–530
- show route forwarding-table vpn command, 725
- show route hidden command
 - for EBGP, 34
 - for IBGP, 550–552, 559
- show route-options community transit command, 29
- show route protocol bgp command
 - for IPv6 case study, 593, 595–596
 - for VPN case study, 793–794, 803
- show route protocol dvmrp command, 418–419
- show route protocol isis command
 - for firewall filter case study, 349–350
 - for IGP discovery, 15, 70
 - for IPv6 case study, 585
- show route protocol ospf command
 - for IGP discovery, 10, 15–16
 - for MPLS, 227
 - for OSPF, 534–535
 - for VPNs
 - draft-Kompella, 760
 - draft-Martini, 772
 - Internet access from non-VRF
 - interface, 765–766
- show route protocol rip command, 785
- show route protocol ripng command, 531–532
- show route protocol static command, 712
- show route receive-protocol bgp command
 - for EBGP, 544
 - for IPv6 case study, 587
 - for MPLS, 244–245
 - for VPN case study, 716
- show route receive-protocol dvmrp command, 420
- show route receive-protocol ripng command, 530–531
- show route resolution unresolved command
 - for IBGP, 550, 552
 - for IPv6 tunneling, 565
- show route source-gateway command, 186–188, 192–193

- show route table c1 command, 713–716
- show route table c1-ospf command, 736–737
- show route table c2-ospf command, 742
- show route table c3 command, 791–792
- show route table c4 command, 789, 796–797, 799–802
- show route table http command, 324
- show route table inet.2 command, 416–418
- show route table inet.3 command
 - for MPLS
 - LDP instance enabling, 133
 - LDP signaled LSP verification, 135, 137
 - LSP forwarding, 216–217
 - OSPF, 233–234
 - routing table integration prefixes, 174–177
 - RSVP signaled, 153–154
 - TE shortcuts, 180–183
 - for VPNs
 - case study, 781–783, 787
 - draft-Martini, 769
- show route table inet6 command, 584
- show route table mpls.0 command, 762–764
- show routing-instances command
 - for firewall filter case study, 371
 - r3, 379–380
 - r4, 384
 - for VPNs, 799
 - with BGP and static routing, 712, 720–721
 - for case study, 802–803
 - draft-Kompella, 754
 - with OSPF, 734–735, 738
 - r1, 808–809
 - r2, 811
 - r3, 815
 - redundancy and route filtering, 739–740
- show routing-options command
 - for firewall filter case study, 371–372
 - r3, 379
 - r4, 383–384
 - for IBGP discovery, 21
 - for IPv6
 - OSPF, 539
 - r3, 605
 - r4, 610–611
 - for MPLS
 - LDP instance enabling, 133–134
 - OSPF, 245
 - for multicasts, 486
 - DVMRP, 415–416
 - MSDP interdomain, 475
 - r3, 495–496
 - r4, 497
 - for VPNs
 - with BGP and static routing, 711, 720
 - draft-Kompella, 749
 - with OSPF, 729
- show routing-options policy-statement command, 569
- show routing-options rib command for IPv6
 - case study, 583, 591
 - IBGP, 560
 - tunneling, 569
- show routing-options route-distinguisher-id command, 753
- show routing-options static command
 - for IGP discovery, 75
 - for Internet access from non-VRF interface, 764
- show rsvp interface command
 - for Layer 3 VPNs, 707
 - for MPLS
 - bandwidth reservation, 223
 - case study, 247
 - OSPF, 231, 235
 - for RSVP
 - authentication configuration, 151
 - signal enabling, 149
 - signaled LSPs, 154
 - for secondary paths, 196, 200–201
- show rsvp lsp ingress command, 208
- show rsvp neighbor command for MPLS
 - OSPF, 246
 - RSVP signal enabling, 150
- show rsvp session command
 - for MPLS
 - constrained routing, 158
 - OSPF, 232–233, 240
 - RSVP signaled LSPs, 152, 157
 - for RE firewall filters, 280, 289, 294
 - for VPNs
 - Layer 3, 707–708
 - mapping to LSPs, 761
- show rsvp session detail command for MPLS
 - ERO constrained LSPs, 160
 - LSP rate limiting, 310–311
 - OSPF, 240
 - RSVP signaled LSPs, 153–155

- show rsvp session egress command, 218, 220
- show rsvp session ingress command for MPLS
 - Fast Reroute, 204
 - link coloring, 168
 - link protection, 206–207
 - LSP-to-prefix mapping, 186–187, 191–192
 - OSPF, 237, 244
 - secondary paths, 197
- show rsvp session transit command for MPLS
 - Fast Reroute, 204–205
 - OSPF, 237–238
 - secondary paths, 199–200
- show system syslog command, 354
- show ted database detail command, 202
- show ted database extensive command
 - for MPLS
 - CSPF troubleshooting, 171
 - link coloring, 165
 - OSPF, 242
- show term deny-all-else command, 285
- show term ports command, 302
- show term ssh command, 283–284
- show term telnet-in command, 282
- show term telnet-out command, 282–283
- show traceoptions command
 - for CSPF troubleshooting, 170
 - for DVMRP, 428
 - for PIM tracing, 463
- SLARP (Serial Line Address Resolution Protocol) protocol traffic, 341
- source option for IPv6 case study, 597
- source-address option
 - for MSDP, 467
 - for prefix-specific counting, 316
- source-port option for firewall filters
 - case study, 362
 - Filter Based Forwarding, 326
 - RE, 284
- source-port key option, 283
- Source Specific Multicast (SSM)
 - for IGMP, 411
 - for multicast case study, 488
- source-specific trees, 430
- sparse mode, PIM, 430, 441
 - configuring
 - using Auto-RP, 455–459, 455
 - using bootstrap, 441–445, 443
 - RP election problems, 449–450
 - verifying
 - using Auto-RP, 459–463
 - using bootstrap, 445–455, 455
- Sparse option, 434
- SparseDense option, 434
- SPF (Shortest Path First), 161–163
 - link coloring for, 163–167, 163
 - for LSPs, 167–169
 - for RSVP signaled LSPs, 152–154
 - and TEDs, 158
 - troubleshooting, 169–171
- SSH connections
 - port assignments for, 345
 - for RE firewall filters, 296
- SSM (Source Specific Multicast)
 - for IGMP, 411
 - for multicast case study, 488
- standby keyword for MPLS
 - OSPF, 239
 - secondary paths, 194
- static and BGP routing
 - configuring, 708–712, 709
 - in IGP discovery, 75
 - ping testing for, 4
 - verifying, 712–727
- static LSPs, 124
- StreamPlayer application, 423
- StreamPump application, 423
- strict EROs, 158
- strict-high priority, 652
- subnet-prefix-length parameter for
 - firewall filters
 - case study, 366
 - prefix-specific counting, 315
- SVCs, 124
- swap functions, 124
- system stanza
 - for IS-IS baseline
 - r1, 82–83
 - r2, 86–87
 - r3, 90–91
 - r4, 96–97
 - r5, 102–103
 - r6, 106–107
 - r7, 111–112
 - for OSPF baseline
 - r1, 37–38
 - r2, 40–41
 - r3, 44–45
 - r4, 49–50
 - r5, 53–54
 - r6, 57–58
 - r7, 62–63

T

- T1 router
 - for CoS
 - DSCP rewrites, 637–638, 640–641
 - loss priority, 648–649
 - multifield classification, 628–631
 - schedulers, 657–658
 - for EBGP discovery, 28–30
 - for firewall filters
 - Filter Based Forwarding, 327
 - prefix-specific counting, 317–320
 - for IPv6 case study, 597
 - for MSDP interdomain, 478–479
- tables, DSCP rewrite, 636–637, 640
- TACACS+ service port assignments, 345
- tcp-initial option, 299, 301
- TE (traffic engineering). *See* MPLS (Multiple Protocol Label based Switching) and traffic engineering
- TE extension support in CSPF, 162
- TED (Traffic Engineering Database)
 - in CSPF, 158, 161–162
 - in ERO-based routing, 157
 - in Fast Reroute, 202–203, 202
 - with link coloring, 167
 - for RSVP signaled LSPs, 153–154
- telnet command
 - for CoS
 - case study, 670
 - DSCP rewrites, 637–638, 640
 - multifield classification, 630
 - for firewall filters
 - case study, 355–356
 - prefix-specific counting, 317–318
 - RE, 287, 297–298
 - transit, 303–306
 - for IPv6 tunneling, 576–577
 - for MSDP interdomain, 478
 - port assignments for, 345
 - for router access, 4–5
 - for saving time, 3
 - for VPNs
 - with BGP and static routing, 716–717
 - case study, 784–785, 793–794, 797
 - draft-Kompella, 759
 - draft-Martini, 772
- test bed topology, 5–7, 6
- test-cflowd log file, 336
- topology, OoB, 3–4, 3
- ToS (Type of Service) field, 638
- traceroute command
 - for EBGP, 35
 - for firewall filters
 - case study, 356, 359–360, 363, 369, 372
 - Filter Based Forwarding, 327
 - prefix-specific counting, 320
 - traffic sampling, 333
 - for IGP discovery, 15–16, 19
 - r1, 77, 80–81
 - r3, 69, 77
 - r6, 76–77
 - r7, 72
 - for IPv6
 - addresses, 520
 - case study, 584–585, 597
 - IBGP, 552–553, 556, 559–561
 - OSPF, 537
 - RIPng, 532
 - tunneling, 576–577
 - for MPLS
 - active prefixes, 178
 - ERO constrained LSPs, 161
 - LDP signaled LSP verification, 138–140
 - LSP forwarding, 215–216
 - LSP policing, 312
 - OSPF, 234–235
 - routing table integration prefixes, 176–177
 - TE shortcuts, 182–184
 - for multifield classification, 628–629
 - port assignments for, 345
 - for VPNs
 - with BGP and static routing, 719–720, 723–724
 - case study, 782, 785, 795, 797–799, 803–804
 - draft-Kompella, 760
 - draft-Martini, 773
 - Internet access from non-VRF interface, 765
 - with OSPF, 739
- traceroute routing-instance c1 command, 719
- traceroute routing-instance c1-ospf command, 742
- traceroute routing-instance c4 command, 797
- tracing
 - DVMRP, 427–429
 - PIM, 463–464

traffic engineering (TE). *See* MPLS (Multiple Protocol Label based Switching) and traffic engineering

traffic-engineering bgp-igp action, 184

Traffic Engineering Database (TED)

- in CSPF, 158, 161–162
- in ERO-based routing, 157
- in Fast Reroute, 202–203, 202
- with link coloring, 167
- for RSVP signaled LSPs, 153–154

traffic-engineering keyword, 237

traffic protection in MPLS, 194

- Fast Reroute in, 201–205, 202
- link protection in, 205–208
- preemption in, 208–214
- secondary paths, 194–201
- summary, 214

traffic sampling, 329

- case study, 376–393
- cflowd export, 334–337
- configuring, 330–332
- port mirroring for, 338–343, 338, 342–343
- review questions, 394–399
- review questions, answers to, 400–401
- summary, 343–345
- verifying, 332–334

transit firewall filters

- applying and verifying, 303–307
- creating, 299–303

transit LSRs, policing on, 309

transit switch for Fast Reroute, 204–205

transport-address keyword, 135

troubleshooting

- CSPF, 169–171
- interfaces, 341–342
- Layer 3 VPNs, 714–715
- OSPF3, 538–540
- PIM-SM RP elections, 449–450
- RSVP, 154–157

TS PIC (tunnel services Physical Interface Card), 404

tunneling IPv6, 561, 562

- configuring, 562–567, 566
- IBGP and EBGP adjustments for, 569–577
- summary, 577
- verifying, 567–569

Type of Service (ToS) field, 638

U

unicast addresses

- Format Prefixes for, 512
- scoping for, 511

up command, 513

upside-down routing, 441

user accounts, 4

V

v6-default policy, 584

validation techniques, IS-IS case study, 67–82, 82

VCs (Virtual Circuits), 124

verifying

- COS
 - BA classification, 634–635
 - DSCP rewrites, 639–642
 - loss priority, 646–650
 - multifield classification, 628–631
 - RED profiles, 664–666
 - schedulers, 655–659
- firewall filters
 - cflowd export, 335–337
 - Filter Based Forwarding, 326–328
 - ICMP policing, 308–309
 - LSP policing, 312–313
 - port mirroring, 340–343, 340, 342–343
 - PSCP, 317–320
 - RE, 286–299
 - traffic sampling, 332–334
 - transit, 303–307
- IBGP, 20–24
- IGP
 - core, 7–10
 - for interface operation, 5
 - redistribution, 10–19
- IPv6
 - addressing, 515–520
 - EBGP, 543–546
 - IBGP, 558–561
 - OSPF, 534–537
 - RIPng, 529–532
 - route redistribution, 534–537
 - router advertisements, 520–521
 - tunneling, 567–569

- MPLS and traffic engineering
 - active prefixes, 178–179
 - CSPF constrained LSPs, 167–169
 - ERO constrained LSPs, 159–161
 - Fast Reroute, 204–205
 - LDP signaled LSPs, 134–140
 - link protection, 206–208
 - LSP-to-prefix mapping, 191–193
 - RSVP signaled LSPs, 151–154
 - secondary paths, 197–201
 - multicast
 - DVMRP, 416–427, 421
 - IGMP, 408–411
 - MSDP interdomain, 475–479
 - MSDP with Any-Cast, 470–472
 - PIM DM, 433–440
 - PIM SM using Auto-RP, 459–463
 - PIM SM using bootstrap, 445–455
 - OoB networks, 2–3
 - telnet for, 4–5
 - topology in, 3–4, 3
 - VPNs
 - with BGP and static routing, 712–727
 - draft-Kompella, 755–766
 - draft-Martini, 769–773
 - Layer 3, 707–708
 - OSPF, 736–739
 - redundancy and route filtering, 739–746
 - Virtual Circuits (VCs), 124
 - vpn switch, 746
 - vpnb-icmp counter, 807
 - VPNs (virtual private networks), 698–699, 699
 - case study, 775–776, 775, 777
 - analysis, 778–807
 - configurations, 807–819
 - Layer 2, 746–747
 - draft-Kompella, 747–750, 748
 - draft-Kompella configuring, 750–755
 - draft-Kompella verifying, 755–766
 - draft-Martini configuring, 766–768
 - draft-Martini verifying, 769–773
 - Internet access from non-VRF
 - interface, 764–766
 - mapping to LSPs, 760–764
 - summary, 773–774
 - Layer 3, 699–700, 700
 - with BGP and static routing, 708–712, 709
 - configuring, 700–707, 701
 - with OSPF and PE-CE, 727–731, 728
 - with OSPF configuring, 731–736
 - with OSPF verifying, 736–739
 - summary, 746
 - verifying, 707–708
 - review questions, 820–824
 - review questions, answers to, 825–827
 - summary, 774–775
 - VRF interface, 699, 700, 727
 - vrf-table-label, 726, 746, 804
 - vrf-target option for VPNs, 726
 - with BGP and static routing, 710
 - case study, 788
 - with OSPF, 732
 - VRRP service port assignments, 345
 - vt-interface, 726, 746, 804–805
-
- W**
- Wlisten application, 423
 - Wsend application, 423