

Index

Networking is a field that is pockmarked with acronyms. Rather than provide a separate glossary (with most of the entries being acronyms), this index also serves as a glossary for all the acronyms used in the book. The primary entry for the acronym appears under the acronym name. For example, all references to the Internet Control Message Protocol appear under ICMP. The entry under the compound term “Internet Control Message Protocol” refers back to the main entry under ICMP.

The notation “definition of” appearing with a C function refers to the boxed function prototype for that function, its primary description. The “definition of” notation for a structure refers to its primary definition. Some functions also contain the notation “source code” if the source code implementation for that function appears in the text.

- 4.1cBSD, 98
- 4.2BSD, 20–21, 70, 79–80, 98–100, 106, 166, 390, 412, 536–537, 589
- 4.3BSD, 21, 51, 261, 371–372, 536
 - Reno, 21, 68, 74, 210, 388–389, 485, 588, 711, 737, 755
 - Tahoe, 21
- 4.4BSD, 21, 27, 34, 74, 76, 98–100, 103, 134, 166, 208, 212, 215, 253, 420, 466, 477, 486, 494, 737, 788, 829–832
- 4.4BSD-Lite, 20–21, 954
- 4.4BSD-Lite2, 20–21, 926
- 64-bit alignment, 72, 873
- 64-bit architectures, 28–29, 79, 152, 918
- 6bone (IPv6 backbone), 887–889
 - test address, 879
- 6to4, 889

- Abell, V. A., 897
- absolute name, DNS, 303

- absolute time, 704
- accept function, 14–15, 37–38, 63, 68, 75, 104–105, 107–112, 114–118, 120, 122, 126–127, 133–135, 138–140, 147, 165, 176, 180, 198, 208, 241, 251, 263, 269, 278, 307, 320, 330–331, 333, 340, 355–356, 359–360, 373, 375, 377–379, 421, 432, 436, 461–463, 649, 656, 658, 675, 681, 683–684, 710, 717, 777, 818, 826, 829–834, 836–838, 841–842, 844–847, 850, 915, 923, 933–934, 938
 - connection abort, 139–141
 - definition of, 109
 - nonblocking, 461–463
- ACK (acknowledgment flag, TCP header), 38–39, 44, 58
 - delayed, 220, 237, 923
- acknowledgment flag, TCP header, *see* ACK
- active
 - close, 39–41, 43–44, 47–48, 62, 914, 916, 921
 - open, 37–38, 41, 45, 48, 53, 894
 - socket, 104

- addr member, 862
- ADDR_length member, 860, 862
- ADDR_offset member, 860, 862
- address
 - 6bone test, 879
 - administratively scoped IPv4 multicast, 553
 - alias, 103, 877
 - broadcast, 531–532
 - classless, 874–875
 - ethernet mapping, picture of, IPv4 multicast, 550
 - ethernet mapping, picture of, IPv6 multicast, 550
 - global unicast, 878–879
 - IPv4, 874–877
 - IPv4 destination, 871
 - IPv4 multicast, 549–551
 - IPv4 source, 871
 - IPv4-compatible IPv6, 880
 - IPv4-mapped IPv6, 93, 322, 333, 354–360, 745, 879–880
 - IPv6, 877–881
 - IPv6 destination, 873
 - IPv6 multicast, 551–552
 - IPv6 source, 873
 - link-local, 881
 - loopback, 111, 365, 432, 876, 880
 - multicast, 549–553
 - multicast group, 549
 - picture of, IPv6 multicast, 551
 - private, 876
 - site-local, 881
 - subnet, 875–876, 951
 - unspecified, 876, 881
 - well-known, 52
 - wildcard, 53, 87, 102, 122, 126, 147, 211, 322, 354–355, 357, 362, 373, 560, 562, 568, 581–582, 608, 610–611, 772, 779, 876, 881
- address request, ICMP, 739, 883
- Address Resolution Protocol, *see* ARP
- addrinfo structure, 99, 315–317, 319, 321, 323–324, 330, 457, 745, 757
 - definition of, 315
- administratively scoped IPv4 multicast address, 553
- admin-local multicast scope, 552
- Advanced Programming in the UNIX Environment, *see* APUE
- AF_ versus PF_, 98–99
- AF_INET constant, 7–8, 10, 72–73, 83, 86, 93, 97, 244, 310, 322, 361, 497, 745, 775
- AF_INET6 constant, 32, 72–73, 83, 93, 97, 227, 322, 497, 745, 775, 941
- AF_ISO constant, 98
- AF_KEY constant, 97–98, 511
- AF_LINK constant, 73, 497, 502, 591
- AF_LOCAL constant, 73, 97–98, 412, 414, 416, 418–419
- AF_NS constant, 98
- AF_ROUTE constant, 97–98, 213, 465, 485–486, 492, 495, 497
- AF_UNIX constant, 98, 412
- AF_UNSPEC constant, 254, 316, 322, 327, 329–330, 332, 339, 482, 497
- AH (authentication header), 719, 951
- AI_CANONNAME constant, 317, 324
- AI_PASSIVE constant, 320, 322, 324–325, 330, 620, 941
- ai_addr member, 315, 317, 321
- ai_addrlen member, 315, 317, 320
- ai_canonname member, 315, 317, 321
- ai_family member, 315–317, 322
- ai_flags member, 315–316, 322
- ai_next member, 315–316
- ai_protocol member, 315–317, 319
- ai_socktype member, 315–317, 319–320
- aio_read function, 159
- AIX, xxiii, 22, 78, 108, 257, 262, 306, 486, 538
- alarm function, 381, 383–384, 409, 432, 539, 541, 547, 603–604, 607, 620, 803
- Albitz, P., 304, 349, 947
- alias address, 103, 877
- alignment, 150, 714, 721
 - 64-bit, 72, 873
- all-hosts multicast group, 550
- Allman, E., 315
 - M., 35, 208, 360, 947–948, 952
- all-nodes multicast group, 552
- all-routers multicast group, 550, 552
- Almquist, P., 215, 870, 948
- American National Standards Institute, *see* ANSI
- American Standard Code for Information Interchange, *see* ASCII
- ancillary data, 395–398
 - object, definition of, 396
 - picture of, IP_RECVDSTADDR, 394
 - picture of, IP_RECVIF, 591
 - picture of, IPV6_DSTOPTS, 722
 - picture of, IPV6_HOPLIMIT, 615
 - picture of, IPV6_HOPOPTS, 722
 - picture of, IPV6_NEXTHOP, 615
 - picture of, IPV6_PKTINFO, 615
 - picture of, IPV6_RTHDR, 727
 - picture of, IPV6_TCLASS, 615
 - picture of, SCM_CREDS, 397
 - picture of, SCM_RIGHTS, 397
- ANSI (American National Standards Institute), 7
 - C, 7–9, 29, 70–71, 80–81, 399, 466, 681, 683, 685, 774, 910, 945
- anycasting, 529, 952
- Apache Web server, 834
- API (application program interface), 6

- sockets, 8
- application
 - ACK, 206
 - protocol, 4, 421
- APUE (Advanced Programming in the UNIX Environment), xx, 953
- argc variable, 370
- argument passing, thread, 682–685
- ARP (Address Resolution Protocol), 34, 100, 234, 249, 467, 481, 497–498, 530, 532, 740, 794
 - cache operations, `ioctl` function, 481–483
- arp program, 482
- arp_flags member, 481
- arp_ha member, 481–482
- arp_pa member, 481–482
- arpreq structure, 467, 481
 - definition of, 481
- ASCII (American Standard Code for Information Interchange), 8–9, 82–83, 110, 304, 916
- asctime function, 685
- asctime_r function, 685
- asynchronous
 - error, 240, 249, 252–253, 769–786
 - I/O, 160, 468, 663
 - I/O model, 158–159
- Asynchronous Transfer Mode, *see* ATM
- at program, 364
- ATF_COM constant, 481–482
- ATF_INUSE constant, 481–482
- ATF_PERM constant, 481–482
- ATF_PUBL constant, 481–482
- Atkinson, R. J., 511, 719, 951
- ATM (Asynchronous Transfer Mode), 952
- atoi function, 427
- attack, denial-of-service, 46, 108, 180, 463, 934
- audio/video profile, *see* AVP
- authentication header, *see* AH
- autoconf program, 78, 904
- automatic tunnel, 880
- AVP (audio/video profile), 575
- awk program, xxiii, 26

- backoff, exponential, 598, 802
- Baker, F., 215, 772, 870–871, 948, 952
- bandwidth-delay product, 209
- basename program, 26
- bash program, 127, 143
- batch input, 169–172
- Belinchon, M., 285, 953
- Bellovin, S. M., 108, 711, 948
- Bentley, J. L., xxiii
- Berkeley Internet Name Domain, *see* BIND
- Berkeley Software Distribution, *see* BSD
- Berkeley-derived implementation, definition of, 20
- Bestler, C., 285, 953
- BGP (Border Gateway Protocol, routing protocol), 62
 - bibliography, 947–954
 - big picture, TCP/IP, 32–34
 - big-endian byte order, 77
 - BIND (Berkeley Internet Name Domain), 305–306, 341–342, 498
 - bind function, 13, 29, 37–38, 45, 52–53, 68, 70–71, 74, 76, 99, 101–104, 109, 111, 118, 120, 126, 140, 146–147, 178, 203, 210–213, 236–237, 242, 245, 248, 250, 252, 254, 261–262, 265, 317, 320, 330, 355, 361–362, 371, 373, 379, 413, 415–416, 419–420, 432–433, 564, 572, 576–577, 581, 585, 609–610, 613, 616, 630, 736, 739, 759, 769, 772, 777, 779, 792, 876, 881, 915, 921, 933, 935, 940
 - definition of, 101
 - bind_ack structure, 862
 - bind_connect_listen function, 213
 - bind_req structure, 860
 - binding interface address, UDP, 608–612
 - Black, D., 215, 870–871, 948, 952
 - black magic, 420
 - Blake, S., 215, 870–871, 948, 952
 - blocking, head of line, 31, 293–299
 - blocking I/O model, 154–155
 - BOOTP (Bootstrap Protocol), 57, 62, 532
 - Bootstrap Protocol, *see* BOOTP
 - Border Gateway Protocol, routing protocol, *see* BGP
 - Borman, D. A., 35, 38–39, 51, 57, 106, 108, 599, 721, 753, 948, 950
 - Bostic, K., 20, 737, 951
 - Bound, J., 28, 71, 216, 346–347, 361, 504, 949
 - boundaries, message, 31
 - Bourne shell, 26
 - Boyd, C. A., xxii
 - BPF (BSD Packet Filter), 32, 34, 98, 787–790, 793, 810
 - Braden, R. T., 35, 38–39, 43–44, 203, 237, 247, 532, 576, 589, 599, 753, 877, 948, 950
 - Bradner, S., 28, 948
 - broadcast, 199, 529–547
 - address, 531–532
 - flooding, 558
 - IP fragmentation and, 537–538
 - multicast versus, 553–556
 - storm, 534
 - versus unicast, 532–535
 - BSD (Berkeley Software Distribution), 20
 - networking history, 20–21
 - Packet Filter, *see* BPF
 - BSD/OS, 20–21, 98, 108, 167, 392, 808
 - buf member, 856
 - buffer sizes, 55–61
 - buffering, double, 789
 - BUFFSIZE constant, definition of, 902

- BUFLen constant, 491
- bufmod STREAMS module, 790
- Bush, R., 304, 948
- Butenhof, D. R., 676, 948
- byte manipulation functions, 80–81
- byte order
 - big-endian, 77
 - functions, 77–80
 - host, 77, 103, 110, 120, 148, 737, 740, 915
 - little-endian, 77
 - network, 69, 79, 82, 110, 152, 311–312, 319, 737–738, 740, 918
- byte-stream protocol, 9, 31, 34, 93, 98, 392, 415, 435, 661

- C standard, ISO C99, 15
- Cain, B., 564, 948
- calloc function, 478, 693
- canonical name record, DNS, *see* CNAME
- caplen member, 809
- Caren, K., xxiii
- Carlson, J., xxii
- Carpenter, B., 871, 889, 948, 952
- Carrel, D., 524, 949
- carriage return, *see* CR
- CDE (Common Desktop Environment), 27
- CERT (Computer Emergency Response Team), 108, 934, 948
- CFG, 790
- chargen port, 61, 189, 349, 380, 930, 934
- checksum, 948
 - ICMPv4, 737, 753, 806, 882
 - ICMPv6, 738, 753–754, 882
 - IGMP, 753
 - IPv4, 214, 737, 753, 871
 - IPv6, 216, 738, 873
 - TCP, 753
 - UDP, 259, 497–499, 753, 793–814
- Cheriton, D., 558, 950
- Cheswick, W. R., 108, 711, 948
- Child structure, 837–838, 842
- child_main function, 827, 830–831, 833, 835, 841
- child_make function, 827, 833, 835, 837
- child.h header, 837
- CIDR (classless interdomain routing), 874–875
- Clark, J. J., xxiii
- classless address, 874–875
- classless interdomain routing, *see* CIDR
- cleanup function, 799, 810
- client structure, 775, 777–780, 783
- client/server
 - design alternatives, 817–850
 - examples road map, 16–18
- clock resolution, 162
- clock_gettime function, 705
- close
 - active, 39–41, 43–44, 47–48, 62, 914, 916, 921
 - passive, 39–41, 47–48
 - simultaneous, 40–41, 48
- close function, 12, 15, 37, 39–40, 47, 63, 101, 114–115, 117, 120, 137, 172–173, 189, 202–206, 236, 279, 343–344, 446, 462, 464, 681, 707, 780, 868, 915, 919, 938
- definition of, 117
- CLOSE_WAIT state, 41
- CLOSED state, 40–41, 47–48, 63, 101, 104, 207
- closefrom function, 369
- closelog function, 365–367
- definition of, 367
- CLOSING state, 41
- cmcred_euid member, 429
- cmcred_gid member, 429
- cmcred_groups member, 429
- cmcred_ngroups member, 429
- cmcred_pid member, 429
- cmcred_uid member, 429
- CMGROUP_MAX constant, 429
- CMSG_DATA macro, 425
- definition of, 397
- CMSG_FIRSTHDR macro, 398, 590, 730
- definition of, 397
- CMSG_LEN macro, 398, 901
- definition of, 397
- CMSG_NXTHDR macro, 398, 590, 730
- definition of, 397
- CMSG_SPACE macro, 398, 901
- definition of, 397
- cmsg_control member, 398
- cmsg_data member, 396–397, 425, 722
- cmsg_len member, 394, 396–398
- cmsg_level member, 394, 396, 616–619, 732
- cmsg_type member, 394, 396, 616–619, 732
- msgcred structure, 429–430
- definition of, 429
- msgghdr structure, 394, 396–398, 409, 425, 615–619, 722, 727, 732
- definition of, 396
- CNAME (canonical name record, DNS), 305, 307, 310
- code field, ICMP, 882
- coding
 - style, 8, 12
 - TLV, 720
- Coene, L., 267, 952
- Common Desktop Environment, *see* CDE
- Common Standards Revision Group, *see* CSRG
- completed connection queue, 104
- completely duplicate binding, 211–213, 922
- Computer Emergency Response Team, *see* CERT
- Computer Systems Research Group, *see* CSRG
- concurrent programming, 698
- concurrent server, 15, 114–116

- one child per client, TCP, 822–825
- one thread per client, TCP, 842–843
- port numbers and, 52–55
- UDP, 612–614
- condition variable, 701–705
- config.h header, 425, 904–909
- configure program, 904
- congestion avoidance, 461, 596, 950
- CONIND_number member, 860, 862
- conn_req structure, 863
- connect function, 7, 9, 11, 13, 29, 37–38, 45, 52, 63, 68, 74, 76, 99–102, 104–105, 107, 118, 120, 125–127, 135, 140, 146, 152, 165, 184, 208, 213, 237, 239, 241, 245, 249, 252–257, 261–262, 307, 314, 317, 319, 327–329, 337, 350, 355, 357–359, 361–362, 367, 382–383, 386, 408–409, 415–416, 420, 432, 436, 448–449, 451–452, 454, 457–459, 461, 464, 694, 696, 707, 717, 736, 739, 769, 772, 777, 826, 892–893, 915, 920–921, 933, 935
 - definition of, 99
 - interrupted, 451–452
 - nonblocking, 448–461
 - timeout, 382–383
 - UDP, 252–255
- connect_nonb function, 449, 454
 - source code, 450
- connect_timeo function, 382
 - source code, 382
- connected TCP socket, 109
- connected UDP socket, 252
- connection
 - abort, accept function, 139–141
 - establishment, SCTP, 44–50
 - establishment, TCP, 37–43
 - persistent, 825
 - queue, completed, 104
 - queue, incomplete, 104
 - termination, SCTP, 44–50
 - termination, TCP, 37–43
- connectionless, 34
- connection-oriented, 35
- Conrad, P., 285, 953
- const qualifier, 81, 103, 162
- Conta, A., 871, 882, 884, 948, 952
- continent-local multicast scope, 552
- control information, *see* ancillary data
- conventions
 - source code, 7
 - typographical, 7
- COOKIE-ECHOED state, 47–48
- COOKIE-WAIT state, 47–48
- Coordinated Universal Time, *see* UTC
- copy
 - deep, 321
 - shallow, 321
- copy-on-write, 675
- copyto function, 680, 944
- core file, 369
- CORRECT_prim member, 865
- cpio program, 26
- CPU_VENDOR_OS constant, 78
- CR (carriage return), 9, 895, 916
- crashing and rebooting of server host, 144–145
- crashing of server host, 144
- Crawford, M., 551, 948–949
- credentials, receiving sender, 429–431
- creeping featurism, 741
- cron program, 364, 366
- CSRG (Computer Systems Research Group), 20
- CSRG (Common Standards Revision Group), 25
- ctermid function, 685
- ctime function, 15, 685
- ctime_r function, 685
- CTL_NET constant, 496–497, 499
- daemon, 16
 - definition of, 363
 - process, 363–380
- daemon function, 367
- daemon_inetd function, 377–379
 - source code, 377
- daemon_init function, 367–372, 378–380
 - source code, 368
- daemon_proc variable, 369, 378, 910
- data formats, 147–151
 - binary structures, 148–151
 - text strings, 147–148
- Data Link Provider Interface, *see* DLPI
- data member, 405, 408
- datagram
 - service, reliable, 597–608
 - socket, 33
 - truncation, UDP, 594
- datalink socket address structure, routing socket, 486–487
- daytime port, 61–62
- DCE (Distributed Computing Environment), 597
 - RPC, 62
- de Groot, G. J., 876, 952
- deadlock, 916
- debugging techniques, 891–897
- deep copy, 321
- Deering, S. E., 55–57, 216, 529, 550, 564, 721, 726, 871, 873, 877–879, 882, 884, 948–949, 951–952
- delayed ACK, 220, 237, 923
- delta time, 704
- denial-of-service attack, 46, 108, 180, 463, 934
- DePasquale, D., xxiii
- descriptor
 - passing, 420–428, 769, 836–842
 - reference count, 117, 421

- set, 162
 - design alternatives, client/server, 817–850
 - DEST_length member, 863
 - DEST_offset member, 863
 - destination
 - address, IPv4, 871
 - address, IPv6, 873
 - IP address, recvmsg function, receiving, 588–593
 - options, IPv6, 719–725
 - unreachable, fragmentation required, ICMP, 56, 771, 883
 - unreachable, ICMP, 100–101, 144, 200, 249, 762, 764–765, 771, 775, 865, 883–884
 - destructor function, 690
 - detached thread, 678
 - Detailed Network Interface, *see* DNI
 - /dev/bpf device, 799
 - /dev/console device, 364
 - /dev/klog device, 364
 - /dev/kmem device, 482, 484
 - /dev/log device, 364
 - /dev/null device, 370, 701
 - /dev/poll device, 402–404
 - /dev/tcp device, 859
 - /dev/zero device, 830, 836
 - DF (don't fragment flag, IP header), 56, 444, 771, 871, 883
 - DG structure, 666
 - dg_cli function, 244–246, 256–257, 383, 385–386, 419, 535–536, 541, 544–545, 547, 570, 599, 728, 772, 925
 - dg_echo function, 242, 244–245, 257, 260, 419, 592, 666, 668, 729
 - dg_send_recv function, 599, 601, 604, 606, 620
 - source code, 602
 - DHCP (Dynamic Host Configuration Protocol), 62, 530, 532
 - Differentiated Services, 870–871
 - Digital Unix, 257, 346, 700
 - disaster, recipe for, 684
 - discard port, 61
 - DISCON_reason member, 865
 - diskless node, 34
 - DISPLAY environment variable, 411
 - Distributed Computing Environment, *see* DCE
 - DL_ATTACH_REQ constant, 790
 - DLPI (Data Link Provider Interface), 32, 34, 98, 787, 790–791, 793, 810, 854, 954
 - DLT_EN10MB constant, 808
 - DNI (Detailed Network Interface), 27
 - DNS (Domain Name System), 9, 57, 62, 239, 303–306, 311–312, 789
 - absolute name, 303
 - alternatives, 306
 - canonical name record, *see* CNAME
 - mail exchange record, *see* MX
 - pointer record, *see* PTR
 - resource record, *see* RR
 - round robin, 822
 - simple name, 303
 - do_get_read function, 695–697, 705
 - dom_family member, 99
 - Domain Name System, *see* DNS
 - domain structure, 99
 - don't fragment flag, IP header, *see* DF
 - dotted-decimal notation, 874
 - double buffering, 789
 - DP_POLL constant, 403
 - dp_fds member, 403
 - dp_nfds member, 403
 - dp_timeout member, 403
 - Draves, R., 317, 879, 949, 951
 - driver, STREAMS, 851
 - DSCP, 215, 870–871
 - dual-stack host, 322, 325, 330, 332–333, 353–357, 359
 - definition of, 34
 - dup function, 829
 - dup2 function, 373
 - duplicate
 - lost, 43
 - wandering, 43
 - Durst, W., 315
 - Dynamic Host Configuration Protocol, *see* DHCP
 - dynamic port, 51
-
- EACCES error, 199, 535
 - EADDRINUSE error, 103, 451, 609, 921
 - EAFNOSUPPORT error, 83, 254
 - EAGAIN error, 436, 658, 677
 - EAI_AGAIN constant, 321
 - EAI_BADFLAGS constant, 321
 - EAI_FAIL constant, 321
 - EAI_FAMILY constant, 321
 - EAI_MEMORY constant, 321
 - EAI_NONAME constant, 321
 - EAI_OVERFLOW constant, 321
 - EAI_SERVICE constant, 321
 - EAI_SOCKTYPE constant, 321
 - EAI_SYSTEM constant, 321
 - EBUSY error, 790
 - echo port, 61–62, 380
 - echo reply, ICMP, 735, 741, 883–884
 - echo request, ICMP, 735, 739, 741, 883–884
 - ECN, 215, 870–871
 - ECONNABORTED error, 140, 463
 - ECONNREFUSED error, 13, 99, 257, 416, 451, 771, 865, 883–884
 - ECONNRESET error, 142, 145, 200, 921
 - EDESTADDRREQ error, 253
 - EEXIST error, 495

- EHOSTDOWN error, 884
- EHOSTUNREACH error, 100–101, 144, 201–202, 771, 865, 883–884
- EINPROGRESS error, 436, 448–449
- EINTR error, 90, 134–135, 138, 162, 181, 263, 383, 451, 463, 536, 545, 547, 669, 765, 803, 939
- EINVAL error, 162, 232, 274, 475, 514, 648, 651, 775, 915
- EISCONN error, 253, 451
- EMSGSIZE error, 59, 225, 537, 771, 883, 925
- encapsulating security payload, *see* ESP
- end of option list, *see* EOL
- end-of-file, *see* EOF
- ENETUNREACH error, 100, 144, 199
- ENOBUFS error, 60
- ENOENT error, 514
- ENOMEM error, 496
- ENOPROTOPT error, 197, 883–884
- ENOSPC error, 83
- ENOTCONN error, 253, 451
- environ variable, 113
- environment variable
 - DISPLAY, 411
 - LISTENQ, 107
 - PATH, 23, 113
- EOL (end of option list), 709, 713, 945
- EOPNOTSUPP error, 231, 274
- ephemeral port, 50–51, 53–54, 87, 99, 101–103, 111, 120, 122, 245–246, 250, 262, 341, 416, 613, 769, 772, 779, 915
 - definition of, 50
- EPIPE error, 142–143, 916
- Epoch, 14, 606
- EPROTO error, 140, 463, 832
- Eriksson, H., 885, 949
- err_doit function, source code, 910
- err_dump function, 910
 - source code, 910
- err_msg function, 370, 910
 - source code, 910
- err_quit function, 11, 142, 380, 910
 - source code, 910
- err_ret function, 910
 - source code, 910
- err_sys function, 8, 11–13, 100, 257, 658, 910
 - source code, 910
- errata availability, xxii
- errno variable, 12–13, 30, 83, 140, 165, 167, 181, 184, 200, 249, 308, 321, 343–345, 365, 383, 424, 427, 451, 604, 676–677, 769, 771, 775, 783, 882–884, 910, 913
- error
 - asynchronous, 240, 249, 252–253, 769–786
 - functions, 910–912
 - hard, 99
 - soft, 100
- ERROR_prim member, 862
- ESP (encapsulating security payload), 719, 951
- ESRCH error, 495
- ESTABLISHED state, 40–41, 47–48, 63, 101, 104, 106, 127, 140, 916
 - /etc/hosts file, 306, 348
 - /etc/inetd.conf file, 372–373, 379
 - /etc/irs.conf file, 306
 - /etc/netshvc.conf file, 306
 - /etc/networks file, 348–349
 - /etc/nsswitch.conf file, 306
 - /etc/passwd file, 372
 - /etc/protocols file, 348, 372–373
 - /etc/rc file, 363, 371
 - /etc/resolv.conf file, 254, 306, 317
 - /etc/services file, 61, 311, 319, 348, 372, 379, 933
 - /etc/syslog.conf file, 364, 366, 379
- ETH_P_ARP constant, 792
- ETH_P_IP constant, 792
- ETH_P_IPV6 constant, 792
- Ethernet, 34, 42, 55, 57, 63, 199, 208, 354–355, 471, 473–474, 482, 486, 502, 532, 534–535, 538, 550–551, 554–555, 792, 808–809, 870, 879, 914, 939
- ETIME error, 704
- ETIMEDOUT error, 13, 99–101, 144, 200, 202, 383, 449, 451, 604, 865, 919, 924
- EUI (extended unique identifier), 509, 879, 950
 - 64 format, modified, 879
- EV_ADD constant, 406
- EV_CLEAR constant, 406
- EV_DELETE constant, 406, 408
- EV_DISABLE constant, 406
- EV_ENABLE constant, 406
- EV_EOF constant, 406
- EV_ERROR constant, 406
- EV_ONESHOT constant, 406
- EV_SET macro, 406
 - definition of, 405
- events member, 183, 185, 188
- EVFILT_AIO constant, 406
- EVFILT_PROC constant, 406
- EVFILT_READ constant, 406
- EVFILT_SIGNAL constant, 406
- EVFILT_TIMER constant, 406
- EVFILT_VNODE constant, 406
- EVFILT_WRITE constant, 406
- EWOLDBLOCK error, 155, 203, 207, 386, 435–436, 439, 441–442, 463, 648, 657–658, 671, 945
- examples road map, client/server, 16–18
- exec function, 26, 111–114, 118–119, 147, 372–374, 376–377, 420–423, 676, 825, 850, 934
 - definition of, 113
- exec1 function, 423
 - definition of, 113

- execle function, definition of, 113
- execlp function, definition of, 113
- execv function, definition of, 113
- execve function, definition of, 113
- execvp function, definition of, 113
- exercises, solutions to, 913–946
- exit function, 9, 39, 114, 128, 137, 237, 401–402, 409, 427, 614, 679–680, 910, 935
- expedited data, *see* out-of-band data
- exponential backoff, 598, 802
- extended unique identifier, *see* EUI
- extension headers, IPv6, 719
- external data representation, *see* XDR

- F_CONNECTING constant, 457–459
- F_DONE constant, 459, 697
- F_GETFL constant, 235
- F_GETOWN constant, 234–236, 467
- F_JOINED constant, 706
- F_READING constant, 458–459
- F_SETFL constant, 234–235, 468, 664
- F_SETOWN constant, 234–235, 467, 664
- F_UNLCK constant, 834
- F_WRLCK constant, 834
- f_flags member, 458
- f_tid member, 694
- family_to_level function, 567
- FAQ (frequently asked question), 142, 210
- FASYNC constant, 234
- fcntl function, 114, 191, 233–236, 439, 449, 466–468, 647, 649, 664, 669, 833–834
 - definition of, 235
- fcred structure, 397
- fd member, 183, 185, 188
- FD_CLOEXEC constant, 114
- FD_CLR macro, 376
 - definition of, 163
- FD_ISSET macro, 164
 - definition of, 163
- FD_SET macro, 168, 697
 - definition of, 163
- FD_SETSIZE constant, 163, 166, 177, 185
- FD_ZERO macro, 168
 - definition of, 163
- fd_set datatype, 163–164, 185
- FDDI (Fiber Distributed Data Interface), 34, 550–551
- fdopen function, 399–400
- Feng, W., xxii
- Fenner, B., 564, 948
- Fenner, M. M., xxii
- f_flags member, 405
- fflush function, 400–402
- fgets function, 15, 121, 125–126, 128, 141–142, 153, 167–169, 171, 245, 287, 292, 400–401, 536, 851, 915–916, 924
- Fiber Distributed Data Interface, *see* FDDI
- FIFO (first in, first out), 243
- FILE structure, 402, 679
- file structure, 455, 459, 694–695, 706, 829
- file table, 421
- File Transfer Protocol, *see* FTP
- fileno function, 168, 400
- filter member, 405
- filtering
 - ICMPv6 type, 740–741
 - imperfect multicast, 555
 - perfect, 555
- FIN (finish flag, TCP header), 39–40, 179, 789
- FIN_WAIT_1 state, 40–41
- FIN_WAIT_2 state, 41, 128, 944
- finish flag, TCP header, *see* FIN
- Fink, R., 879, 888, 949
- FIOASYNC constant, 234, 467–468, 664
- FIOGETOWN constant, 467–468
- FIONBIO constant, 234, 467–468
- FIONREAD constant, 234, 399, 409, 467–468
- FIOSETOWN constant, 467–468
- firewall, 893, 948
- first in, first out, *see* FIFO
- flags member, 405
- flock structure, 834
- flooding
 - broadcast, 558
 - SYN, 108, 948
- flow control, 35
 - UDP lack of, 257–261
- flow label field, IPv6, 871
- Floyd, S., 35, 215, 870–871, 947–948, 952
- FNDELAY constant, 234
- fopen function, 851
- fork function, 15–16, 26, 53, 95, 111–115, 118, 120, 122, 126, 132, 139, 175, 243, 263, 368–369, 371, 373–377, 379–380, 405, 420–423, 430, 432, 446–448, 464, 577, 609, 612–614, 675–677, 679, 681, 698, 707, 717, 817–818, 820, 822–823, 825–827, 829–830, 837, 842, 850, 934, 944, 946
 - definition of, 111
- format prefix, 878
- formats
 - binary structures, data, 148–151
 - data, 147–151
 - text strings, data, 147–148
- four-way handshake, 45
 - SCTP, 45–46
- fpathconf function, 209
- fprintf function, 344, 365, 369–370, 439, 443
- fputs function, 9, 11, 121, 125, 168–169, 245, 288, 400–402, 680, 919
- FQDN (fully qualified domain name), 303, 309, 317, 340

- fragmentation, 56–57, 59, 719, 737, 739, 771–772, 870, 873, 883–884, 914, 926, 945
 - and broadcast, IP, 537–538
 - and multicast, IP, 571
 - offset field, IPv4, 871
- frame type, 532, 534–535, 555, 791–792
- Franz, M., xxiii
- free function, 508, 684
- free_ifi_info function, 471, 478
 - source code, 480
- freeaddrinfo function, 321, 327, 345
 - definition of, 321
- FreeBSD, 20–24, 78, 108, 197, 260–262, 299, 405, 469, 473, 497, 538, 658, 666, 710, 775, 882–883, 891, 897, 904, 926, 934, 939–940
- freehostent function, 347
 - definition of, 347
- frequently asked question, *see* FAQ
- fseek function, 400
- fsetpos function, 400
- fstat function, 406
- fstat program, 897
- FTP (File Transfer Protocol), 20, 62, 201, 311–312, 360, 362, 366, 375, 662, 914, 947
- fudge factor, 106, 500
- full-duplex, 36, 415
- Fuller, V., 874, 949
- fully buffered standard I/O stream, 401
- fully qualified domain name, *see* FQDN
- function
 - destructor, 690
 - system call versus, 891
 - wrapper, 11–13
- gai_strerror function, 320–321
 - definition of, 321
- Ganguly, S., 285, 953
- Garcia, M., 267, 952
- Garfinkel, S. L., 15, 949
- gated program, 199, 485, 735
- gather write, 389
- Gemellaro, A., xxiii
- generic socket address structure, 70–71
 - new, 72–73
- get_ifi_info function, 469–480, 482, 484, 500–503, 582, 608
 - source code, 474, 501
- get_rtaddrs function, 492–493, 502, 505
- getaddrinfo function, 10, 15, 38, 93, 232, 303, 307, 315–329, 332–336, 338, 340–341, 343, 345–347, 349, 357, 361, 620, 746, 932, 941
 - definition of, 315
 - examples, 324–325
 - IPv6, 322–323
- getc_unlocked function, 685
- getchar_unlocked function, 685
- getconninfo function, 315
- getgrid function, 685
- getgrid_r function, 685
- getgrnam function, 685
- getgrnam_r function, 685
- gethostbyaddr function, 303, 305–306, 310, 315, 341–343, 346, 348–350, 361, 685, 928–930
 - definition of, 310
- gethostbyaddr_r function, 344–346
 - definition of, 345
- gethostbyname function, 303, 305–310, 312, 314–315, 320, 329, 341–350, 355, 361, 685, 929–930, 932–933
 - definition of, 307
- gethostbyname2 function, 342, 346–347
 - definition of, 347
- gethostbyname_r function, 344–346
 - definition of, 345
- gethostent function, 349
- getifaddrs function, 469
- getipnodebyaddr function, 347
- getipnodebyname function, 347
 - definition of, 347
- getlogin function, 685
- getlogin_r function, 685
- getmsg function, 155, 809–810, 855–857, 860, 862, 864–868, 891
 - definition of, 856
- getnameinfo function, 38, 93, 303, 320, 331, 340–341, 343, 345, 347, 349–350, 361, 762, 933
 - definition of, 340
- getnameinfo_timeo function, 350
- getnetbyaddr function, 348
- getnetbyname function, 348
- getopt function, 516, 796
- getpeername function, 52, 68, 75, 117–120, 147, 275, 329, 340, 377–378, 451
 - definition of, 118
- getpid function, 678
- getpmsg function, 855, 857, 868
 - definition of, 857
- getppid function, 111, 938
- getprotobyname function, 348
- getprotobynumber function, 348
- getpwnam function, 373, 685
- getpwnam_r function, 685
- getpwuid function, 685
- getpwuid_r function, 685
- getrlimit function, 919
- getrusage function, 824, 827
- gets function, 15
- getsatypebyname function, 516
- getservbyaddr function, 348
- getservbyname function, 303, 311–314, 320, 329, 343, 348–349, 373
 - definition of, 311

- getservbyport function, 303, 311–314, 343, 348
 - definition of, 312
- getsockname function, 68, 75, 103, 117–120, 146–147, 211, 230, 251, 261, 340, 413–414, 769, 779, 915, 932
 - definition of, 118
- getsockopt function, 76, 165, 191–194, 197, 200, 215, 218, 222–223, 226, 230, 237, 278, 451, 459, 559, 617, 710, 714, 717–718, 733, 740
 - definition of, 192
- gettimeofday function, 582, 606, 704–705, 747
- Gettys, J., 294, 949
- getuid function, 799
- gf_time function, 442
 - source code, 442
- Gierth, A., 462, 949
- GIF (graphics interchange format), 454, 825
- Gilliam, W., xxiii
- Gilligan, R. E., 28, 71, 216, 346–347, 361, 504, 880, 949
- global multicast scope, 552–553
- global routing prefix, 878
- global unicast address, 878–879
- global unicast scope, 878
- gmtime function, 685
- gmtime_r function, 685
- goto, nonlocal, 543, 803
- gpic program, xxiii
- gr_group member, 560
- gr_interface member, 560
- graphics interchange format, *see* GIF
- grep program, 128, 913
- group ID, 429, 431, 676
- group_req structure, 193
 - definition of, 560
- group_source_req structure, 193
 - definition of, 562
- gsr_group member, 562
- gsr_interface member, 562
- gsr_source member, 562
- gtbl program, xxiii

- h_addr_list member, 307–308, 929
- h_addrtype member, 307–308, 932
- h_aliases member, 307–308
- h_errno member, 308, 345–346
- h_length member, 307–308
- h_name member, 307–308, 310, 349
- Haberman, B., 551–552, 949
- hacker, 15, 108, 718, 786, 948
- half-close, 39, 173, 895
- half-open connection, 201, 236
- Handley, M., 571, 949
- Hanson, D. R., xxiii
- hard error, 99
- Harkins, D., 524, 949

- Haug, J., xxiii
- HAVE_MSGHDR_MSG_CONTROL constant, 425
- HAVE_SOCKADDR_SA_LEN constant, 68
- hdr structure, 601, 603–604, 941
- head of line blocking, 31, 293–299
- head, STREAMS, 852
- header
 - extension length, 719, 725
 - length field, IPv4, 870
- Hewlett-Packard, xxiii
- High-Performance Parallel Interface, *see* HIPPI
- high-priority, STREAMS message, 183, 854
- Hinden, R., 55, 57, 216, 529, 721, 726, 871, 873, 877–879, 888, 948–949
- HIPPI (High-Performance Parallel Interface), 55
- historical advanced API, IPv6, 732
- history, BSD networking, 20–21
- Holbrook, H., 558, 950
- Holdrege, M., 267, 952
- home_page function, 455–456, 694, 697
- hop count, routing, 481
- hop limit, 43, 217–218, 552, 559, 563, 566, 617, 750, 755, 757, 761, 772, 872–873, 884
- hop-by-hop options, IPv6, 719–725
- host byte order, 77, 103, 110, 120, 148, 737, 740, 915
- Host Requirements RFC, 948
- HOST_NOT_FOUND constant, 308
- host_serv function, 325–326, 457, 713, 717, 728, 745, 757, 798
 - definition of, 325
 - source code, 326
- hostent structure, 307–308, 310, 345, 347–348, 929
 - definition of, 307
- hostent_data structure, 346
- HP-UX, xxiii, 22, 78, 108, 257, 262, 306, 343, 346, 390, 538, 793
- hsterror function, 308, 310
- HTML (Hypertext Markup Language), 454, 825
- htonl function, 79, 103, 152, 918
 - definition of, 79
- htons function, 8, 311
 - definition of, 79
- HTTP (Hypertext Transfer Protocol), 9, 40, 62, 103, 106, 211, 452, 456, 459, 595, 696, 820, 825, 896
- Huitema, C., 304, 889, 950, 954
- Hypertext Markup Language, *see* HTML
- Hypertext Transfer Protocol, *see* HTTP

- I_RECVFD constant, 420
- I_SENDFD constant, 420
- IANA (Internet Assigned Numbers Authority), 50–52, 215, 311, 950, 953
- IBM, xxiii
- ICMP (Internet Control Message Protocol), 33, 62, 200, 249, 256–257, 735, 739, 742, 755, 896, 922,

- 925
- address request, 739, 883
- code field, 882
- destination unreachable, 100–101, 144, 200, 249, 762, 764–765, 771, 775, 865, 883–884
- destination unreachable, fragmentation
 - required, 56, 771, 883
- echo reply, 735, 741, 883–884
- echo request, 735, 739, 741, 883–884
- header, picture of, 882
- message daemon, implementation, 769–786
- packet too big, 56, 771, 884
- parameter problem, 720, 883–884
- port unreachable, 249, 253, 257, 265, 534, 755, 761, 764, 771, 794, 815, 883–884, 925
- redirect, 485, 497, 883–884
- router advertisement, 735, 741, 883–884
- router solicitation, 735, 883–884
- source quench, 771–772, 883
- time exceeded, 755, 761, 764, 771, 883–884
- timestamp request, 739, 883
- type field, 882
- ICMP6_FILTER socket option, 216, 740
- ICMP6_FILTER_SETBLOCK macro, definition of, 740
- ICMP6_FILTER_SETBLOCKALL macro, definition of, 740
- ICMP6_FILTER_SETPASS macro, definition of, 740
- ICMP6_FILTER_SETPASSALL macro, definition of, 740
- ICMP6_FILTER_WILLBLOCK macro, definition of, 740
- ICMP6_FILTER_WILLPASS macro, definition of, 740
- icmp6_filter structure, 193, 216, 740
- icmpcode_v4 function, 765
- icmpcode_v6 function, 765
- icmpd program, 769, 772, 774–786, 946
- icmpd_dest member, 772
- icmpd_err member, 771, 774, 783–784
- icmpd_errno member, 771
- icmpd.h header, 775
- ICMPv4 (Internet Control Message Protocol version 4), 33–34, 735, 740, 769, 871, 882–884
 - checksum, 737, 753, 806, 882
 - header, 743, 755
 - message types, 883
- ICMPv6 (Internet Control Message Protocol version 6), 33–34, 216, 735, 738, 769, 882–884
 - checksum, 738, 753–754, 882
 - header, 744, 755
 - message types, 884
 - multicast listener done, 884
 - multicast listener query, 884
 - multicast listener report, 884
 - neighbor advertisement, 884
 - neighbor advertisement, inverse, 884
 - neighbor solicitation, 884
 - neighbor solicitation, inverse, 884
 - socket option, 216
 - type filtering, 740–741
- id program, 431
- ident member, 405
- identification field, IPv4, 870
- IEC (International Electrotechnical Commission), 26, 950
- IEEE (Institute of Electrical and Electronics Engineers), 26, 509, 550, 879, 950
- IEEE-IX, 26
- IETF (Internet Engineering Task Force), 28, 947
- if_announcemsg_hdr structure, 487
 - definition of, 488
- if_freenameindex function, 504–508
 - definition of, 504
 - source code, 508
- if_index member, 504, 903
- if_indextoname function, 504–508, 566, 568, 593
 - definition of, 504
 - source code, 506
- if_msghdr structure, 487, 502
 - definition of, 488
- if_name member, 504, 508, 903
- if_nameindex function, 486, 504–508
 - definition of, 504
 - source code, 507
- if_nameindex structure, 504, 507–508, 903
 - definition of, 504
- if_nametoindex function, 486, 504–508, 566–567, 569
 - definition of, 504
 - source code, 505
- ifa_msghdr structure, 487
 - definition of, 488
- ifam_addr member, 489, 493
- ifc_buf member, 469–470
- ifc_len member, 77, 468, 470
- ifc_req member, 469
- ifconf structure, 77, 467–468, 470
 - definition of, 469
- ifconfig program, 23, 25, 103, 234, 471, 480
- IFF_BROADCAST constant, 480
- IFF_POINTOPOINT constant, 480
- IFF_PROMISC constant, 792
- IFF_UP constant, 480
- ifi_hlen member, 473, 478, 502
- ifi_index member, 502
- ifi_info structure, 469, 471, 473, 475, 478, 484, 500, 502, 608
- ifi_next member, 471, 478
- ifm_addr member, 489, 493

- ifm_type member, 502
- ifma_msghdr structure, 487
 - definition of, 488
- ifmam_addrs member, 489
- IFNAMSIZ constant, 504
- ifr_addr member, 469, 480–481
- ifr_broadaddr member, 469, 481, 484
- ifr_data member, 469
- ifr_dstaddr member, 469, 481, 484
- ifr_flags member, 469, 480–481
- ifr_metric member, 469, 481
- ifr_name member, 470, 480
- ifreq structure, 467–468, 470, 475, 477, 480, 484, 568
 - definition of, 469
- IFT_NONE constant, 591
- IGMP (Internet Group Management Protocol), 33–34, 556, 735, 739–740, 871
 - checksum, 753
- ILP32, programming model, 28
- imperfect multicast filtering, 555
- implementation
 - ICMP message daemon, 769–786
 - ping program, 741–754
 - traceroute program, 755–768
- imr_interface member, 560, 562, 568
- imr_multiaddr member, 560, 562
- imr_sourceaddr member, 562
- IN6_IS_ADDR_LINKLOCAL macro, definition of, 360
- IN6_IS_ADDR_LOOPBACK macro, definition of, 360
- IN6_IS_ADDR_MC_GLOBAL macro, definition of, 360
- IN6_IS_ADDR_MC_LINKLOCAL macro, definition of, 360
- IN6_IS_ADDR_MC_NODELOCAL macro, definition of, 360
- IN6_IS_ADDR_MC_ORGLOCAL macro, definition of, 360
- IN6_IS_ADDR_MC_SITELOCAL macro, definition of, 360
- IN6_IS_ADDR_MULTICAST macro, definition of, 360
- IN6_IS_ADDR_SITELOCAL macro, definition of, 360
- IN6_IS_ADDR_UNSPECIFIED macro, definition of, 360
- IN6_IS_ADDR_V4COMPAT macro, definition of, 360
- IN6_IS_ADDR_V4MAPPED macro, 355, 360, 362, 745
 - definition of, 360
- in6_addr structure, 193, 561
 - definition of, 71
- in6_pktinfo structure, 588, 615–617, 731
 - definition of, 616
- IN6ADDR_ANY_INIT constant, 103, 320, 322, 412, 616, 881
- IN6ADDR_LOOPBACK_INIT constant, 880
- in6addr_any constant, 103, 881
- in6addr_loopback constant, 880
- in_addr structure, 70, 193, 308, 310, 358, 560, 563
 - definition of, 68
- in_addr_t datatype, 69–70
- in_cksum function, 753
 - source code, 753
- in_pcbdetach function, 140
- in_port_t datatype, 69
- INADDR_ANY constant, 13, 53, 102–103, 122, 126, 214, 242, 288, 320, 322, 412, 534, 560–563, 859, 876, 915
- INADDR_LOOPBACK constant, 876
- INADDR_MAX_LOCAL_GROUP constant, 915
- INADDR_NONE constant, 82, 901, 915
- in-addr.arpa domain, 304, 310
- in-band data, 645
- incarnation, definition of, 44
- incomplete connection queue, 104
- index, interface, 217, 489, 498, 502, 504–508, 560–563, 566, 569, 577, 616, 731
- INET6_ADDRSTRLEN constant, 83, 86, 901
- inet6_opt_append function, 723–724
 - definition of, 723
- inet6_opt_find function, 725
 - definition of, 724
- inet6_opt_finish function, 723–724
 - definition of, 723
- inet6_opt_get_val function, 725
 - definition of, 724
- inet6_opt_init function, 723–724
 - definition of, 723
- inet6_option_alloc function, 732
- inet6_option_append function, 732
- inet6_option_find function, 732
- inet6_option_init function, 732
- inet6_option_next function, 732
- inet6_option_space function, 732
- inet6_opt_next function, 724–725
 - definition of, 724
- inet6_opt_set_val function, 723–725
 - definition of, 723
- inet6_rth_add function, 727–728
 - definition of, 727
- inet6_rthdr_add function, 732
- inet6_rthdr_getaddr function, 732
- inet6_rthdr_getflags function, 732
- inet6_rthdr_init function, 732
- inet6_rthdr_lasthop function, 732
- inet6_rthdr_reverse function, 732
- inet6_rthdr_segments function, 732
- inet6_rthdr_space function, 732

- inet6_rth_getaddr function, 728, 731
 - definition of, 728
- inet6_rth_init function, 727–728
 - definition of, 727
- inet6_rth_reverse function, 728, 730
 - definition of, 728
- inet6_rth_segments function, 728, 731
 - definition of, 728
- inet6_rth_space function, 727–728
 - definition of, 727
- inet6_srcrt_print function, 730–731
- INET_ADDRSTRLEN constant, 83, 86, 901
- inet_addr function, 9, 67, 82–83, 93
 - definition of, 82
- inet_aton function, 82–83, 93, 314
 - definition of, 82
- inet_ntoa function, 67, 82–83, 343, 685
 - definition of, 82
- inet_ntop function, 67, 82–86, 93, 110, 309, 341, 343, 345, 350, 593, 731
 - definition of, 83
 - IPv4-only version, source code, 85
- inet_pton function, 8–9, 11, 67, 82–85, 93, 290, 333, 343, 930
 - definition of, 83
 - IPv4-only version, source code, 85
- inet_pton_loose function, 93
- inet_srcrt_add function, 713, 715
- inet_srcrt_init function, 712, 715
- inet_srcrt_print function, 714
- inetd program, 61, 114, 118–119, 154, 363, 371–380, 587, 613–614, 825, 850, 897, 934, 945
- Information Retrieval Service, *see* IRS
- INFTIM constant, 184, 902
- init program, 132, 145, 938
- init_v6 function, 749
- initial thread, 676
- in.rdisc program, 735
- Institute of Electrical and Electronics Engineers, *see* IEEE
- int16_t datatype, 69
- int32_t datatype, 69
- int8_t datatype, 69
- interface
 - address, UDP, binding, 608–612
 - configuration, ioctl function, 468–469
 - index, 217, 489, 498, 502, 504–508, 560–563, 566, 569, 577, 616, 731
 - index, recvmsg function, receiving, 588–593
 - logical, 877
 - loopback, 23, 792, 799, 809, 876–877
 - message-based, 858
 - operations, ioctl function, 480–481
 - UDP determining outgoing, 261–262
- interface-local multicast scope, 552–553
- International Electrotechnical Commission, *see* IEC
- International Organization for Standardization, *see* ISO
- Internet, 5, 22
- Internet Assigned Numbers Authority, *see* IANA
- Internet Control Message Protocol, *see* ICMP
- Internet Control Message Protocol version 4, *see* ICMPv4
- Internet Control Message Protocol version 6, *see* ICMPv6
- Internet Draft, 947
- Internet Engineering Task Force, *see* IETF
- Internet Group Management Protocol, *see* IGMP
- Internet Protocol, *see* IP
- Internet Protocol next generation, *see* IPng
- Internet Protocol version 4, *see* IPv4
- Internet Protocol version 6, *see* IPv6
- Internet service provider, *see* ISP
- Internetwork Packet Exchange, *see* IPX
- interoperability
 - IPv4 and IPv6, 353–362
 - IPv4 client IPv6 server, 354–357
 - IPv6 client IPv4 server, 357–359
 - source code portability, 361
- interprocess communication, *see* IPC
- interrupts, software, 129
- inverse, ICMPv6 neighbor advertisement, 884
 - ICMPv6 neighbor solicitation, 884
- I/O
 - asynchronous, 160, 468, 663
 - definition of, Unix, 399
 - model, asynchronous, 158–159
 - model, blocking, 154–155
 - model, comparison of, 159–160
 - model, I/O, multiplexing, 156–157
 - model, nonblocking, 155–156
 - model, signal-driven, 157–158
 - models, 154–160
 - multiplexing, 153–189
 - multiplexing I/O, model, 156–157
 - nonblocking, 88, 165, 234–235, 388, 398, 435–464, 468, 665, 669, 671, 919, 945
 - signal-driven, 200, 234–235, 663–673
 - standard, 168, 344, 399–402, 409, 437, 935, 952
 - synchronous, 160
- ioctl function, 191, 222, 233–234, 399, 403–404, 409, 420, 465–469, 474–475, 477–478, 480–485, 500, 538, 566, 568, 585, 647, 654, 664, 666, 669, 790, 792, 799, 852, 857, 868
 - ARP cache operations, 481–483
 - definition of, 466, 857
 - file operations, 468
 - interface configuration, 468–469
 - interface operations, 480–481
 - routing table operations, 483–484
 - socket operations, 466–467
 - STREAMS, 857–858

- IOV_MAX constant, 390
- iov_base member, 389
- iov_len member, 389, 392
- iovec structure, 389–391, 393, 601
 - definition of, 389
- IP (Internet Protocol), 33
 - fragmentation and broadcast, 537–538
 - fragmentation and multicast, 571
 - Multicast Infrastructure, 571, 584–585
 - Multicast Infrastructure session
 - announcements, 571–575
 - routing, 869
 - spoofing, 108, 948
 - version number field, 869, 871
- ip6_mtuintfo structure, definition of, 619
- ip6.arpa domain, 304
- ip6m_addr member, 619
- ip6m_mtu member, 619
- IP_ADD_MEMBERSHIP socket option, 193, 560, 562
- IP_ADD_SOURCE_MEMBERSHIP socket option, 193, 560
- IP_BLOCK_SOURCE socket option, 193, 560, 562
- IP_DROP_MEMBERSHIP socket option, 193, 560–561
- IP_DROP_SOURCE_MEMBERSHIP socket option, 193, 560
- IP_HDRINCL socket option, 193, 214, 710, 736–738, 753, 755, 790, 793, 805–806
- IP_MULTICAST_IF socket option, 193, 559, 563, 945
- IP_MULTICAST_LOOP socket option, 193, 559, 563
- IP_MULTICAST_TTL socket option, 193, 215, 559, 563, 871, 945
- IP_OPTIONS socket option, 193, 214, 709–710, 718, 733, 945
- IP_RECVSTADDR socket option, 193, 211, 214, 251, 265, 392–396, 587–588, 590, 592, 608, 616, 620, 666, 895
 - ancillary data, picture of, 394
- IP_RECVIF socket option, 193, 215, 395, 487, 588, 590, 592, 608, 620, 666
 - ancillary data, picture of, 591
- IP_TOS socket option, 193, 215, 870, 895
- IP_TTL socket option, 193, 215, 218, 755, 761, 871, 895
- IP_UNBLOCK_SOURCE socket option, 193, 560
- ip_id member, 740, 806
- ip_len member, 737, 740, 806
- ip_mreq structure, 193, 560, 568
 - definition of, 560
- ip_mreq_source structure, 193
 - definition of, 562
- ip_off member, 737, 740
- IPC (interprocess communication), 411–412, 545–547, 675
- ipi6_addr member, 616
- ipi6_ifindex member, 616
- ipi_addr member, 588, 901
- ipi_ifindex member, 588, 901
- IPng (Internet Protocol next generation), 871
 - ipopt_dst member, 714
 - ipopt_list member, 714
 - ipoption structure, definition of, 714
- IPPROTO_ICMP constant, 736
- IPPROTO_ICMPV6 constant, 193, 216, 738, 740
- IPPROTO_IP constant, 214, 394–395, 591, 710
- IPPROTO_IPV6 constant, 216, 395, 615–619, 722, 727
- IPPROTO_RAW constant, 737
- IPPROTO_SCTP constant, 97, 222, 288
- IPPROTO_TCP constant, 97, 219, 288, 519
- IPPROTO_UDP constant, 97
- IPsec, 951
- IPv4 (Internet Protocol version 4), 33, 869
 - address, 874–877
 - and IPv6 interoperability, 353–362
 - checksum, 214, 737, 753, 871
 - client IPv6 server, interoperability, 354–357
 - destination address, 871
 - fragment offset field, 871
 - header, 743, 755, 869–871
 - header length field, 870
 - header, picture of, 870
 - identification field, 870
 - multicast address, 549–551
 - multicast address, ethernet mapping, picture of, 550
 - options, 214, 709–711, 871
 - protocol field, 871
 - receiving packet information, 588–593
 - server, interoperability, IPv6 client, 357–359
 - socket address structure, 68–70
 - socket option, 214–215
 - source address, 871
 - source routing, 711–719
 - total length field, 870
- IPv4-compatible IPv6 address, 880
- IPv4/IPv6 host, definition of, 34
- IPv4-mapped IPv6 address, 93, 322, 333, 354–360, 745, 879–880
- IPv6 (Internet Protocol version 6), xx, 33, 871
 - address, 877–881
 - backbone, *see* 6bone
 - checksum, 216, 738, 873
 - client IPv4 server, interoperability, 357–359
 - destination address, 873
 - destination options, 719–725
 - extension headers, 719
 - flow label field, 871
 - getaddrinfo function, 322–323

- header, 744, 755, 871–874
 - header, picture of, 872
 - historical advanced API, 732
 - hop-by-hop options, 719–725
 - interoperability, IPv4 and, 353–362
 - multicast address, 551–552
 - multicast address, ethernet mapping, picture of, 550
 - multicast address, picture of, 551
 - next header field, 872
 - options, *see* IPv6, extension headers
 - path MTU control, 618–619
 - payload length field, 872
 - receiving packet information, 615–618
 - routing header, 725–731
 - server, interoperability, IPv4 client, 354–357
 - socket address structure, 71–72
 - socket option, 216–218
 - source address, 873
 - source routing, 725–731
 - source routing segments left, 725
 - source routing type, 725
 - sticky options, 731–732
 - IPV6_ADD_MEMBERSHIP socket option, 560–561
 - IPV6_ADDRFORM socket option, 361
 - IPV6_CHECKSUM socket option, 193, 216, 738
 - IPV6_DONTFRAG socket option, 216, 619
 - IPV6_DROP_MEMBERSHIP socket option, 560–561
 - IPV6_DSTOPTS socket option, 193, 395, 732
 - ancillary data, picture of, 722
 - IPV6_HOPLIMIT socket option, 193, 395, 617, 732, 749–750, 873
 - ancillary data, picture of, 615
 - IPV6_HOPOPTS socket option, 193, 395, 732
 - ancillary data, picture of, 722
 - IPV6_JOIN_GROUP socket option, 193, 560, 562
 - IPV6_LEAVE_GROUP socket option, 193, 561
 - IPV6_MULTICAST_HOPS socket option, 193, 559, 563, 617, 873
 - IPV6_MULTICAST_IF socket option, 193, 559, 563, 616
 - IPV6_MULTICAST_LOOP socket option, 193, 559, 563
 - IPV6_NEXTHOP socket option, 193, 217, 395, 617, 732
 - ancillary data, picture of, 615
 - IPV6_PATHMTU socket option, 217, 619
 - IPV6_PKTINFO socket option, 193, 251, 395, 561, 608, 616, 620, 666, 732
 - ancillary data, picture of, 615
 - IPV6_PKTOPTIONS socket option, 732
 - IPV6_RECVDSTOPTS socket option, 217, 722
 - IPV6_RECVHOPLIMIT socket option, 217–218, 617, 749, 873
 - IPV6_RECVHOPOPTS socket option, 217, 722
 - IPV6_RECVPATHMTU socket option, 216–217, 619
 - IPV6_RECVPKTINFO socket option, 217, 616–617, 620
 - IPV6_RECVRTHDR socket option, 218, 727, 729
 - IPV6_RECVTCLASS socket option, 218, 618
 - IPV6_RTHDR socket option, 193, 395, 732
 - ancillary data, picture of, 727
 - IPV6_RTHDR_TYPE_0 constant, 727
 - IPV6_TCLASS socket option, 395, 618, 732, 871
 - ancillary data, picture of, 615
 - IPV6_UNICAST_HOPS socket option, 193, 218, 617, 755, 761, 873
 - IPV6_USE_MIN_MTU socket option, 218, 618–619
 - IPV6_V6ONLY socket option, 218, 357
 - IPV6_XXX socket options, 218
 - ipv6_mreq structure, 193, 560, 569
 - definition of, 560
 - ipv6mr_interface member, 560, 569
 - ipv6mr_multiaddr member, 560
 - IPX (Internetwork Packet Exchange), 952
 - IRS (Information Retrieval Service), 306
 - ISO (International Organization for Standardization), 18, 26, 950
 - ISO 8859, 573
 - ISP (Internet service provider), 875
 - iterative server, 15, 114, 243, 821–822
-
- Jackson, A., 721, 952
 - Jacobson, V., 35, 38–39, 44, 571, 596, 598–599, 737, 788, 790, 896, 949–951
 - Jim, J., 285, 953
 - Jinmei, T., 28, 216, 397, 719, 738, 744, 953
 - joinable thread, 678
 - Jones, R. A., xxii–xxiii
 - Josey, A., 25, 27, 950
 - Joy, W. N., 106, 950
 - Juhasz, I., 267, 952
 - jumbo payload length, 721
 - jumbogram, 872
-
- Kalla, M., 36, 280, 954
 - KAME, 512
 - SCTP implementation, 299
 - Karels, M. J., 20, 315, 737, 951
 - Karn, P., 599, 950
 - Karn's algorithm, 599
 - Karrenberg, D., 876, 952
 - Kashyap, V., 285, 953
 - Katz, D., 550, 710, 950
 - kdump program, 892
 - keep-alive option, 200–202, 238, 923–924
 - Kent, S. T., 511, 719, 950–951
 - Kernighan, B. W., xxii–xxiii, 12, 910, 951
 - kevent function, 405–406, 408
 - definition of, 405

- kevent structure, 405–406, 408
 - definition of, 405
- key management socket, 511–528
- Key structure, 687–688, 690
- kill program, 141–142, 946
- Kouvelas, I., 564, 948
- kqueue function, 405–406, 408
 - definition of, 405
- ktrace program, 891

- `l_fixedpt` member, 580
- `l_len` member, 834
- `l_linger` member, 202–203, 237, 462
- `l_onoff` member, 202–203, 237, 462
- `l_start` member, 834
- `l_type` member, 834
- `l_whence` member, 834
- LAN (local area network), 5, 35, 219, 448, 530, 549, 553–556, 579, 596–597, 879, 885, 888
- Lanciani, D., 98, 238, 951
- LAST_ACK state, 41
- latency, scheduling, 162
- LDAP (Lightweight Directory Access Protocol), 306
- leader
 - process group, 369
 - session, 369
- leak, memory, 345
- Lear, E., 876, 952
- least significant bit, *see* LSB
- Leffler, S., xv, xxii
- `len` member, 809, 856
- Leres, C., 896
- LF (linefeed), 9, 895, 916
- Li, T., 874, 949
- libnet library, 793
- `libnet_build_dnsv4` function, 814
- `libnet_build_ipv4` function, 814
- `libnet_build_udp` function, 814
- `libnet_init` function, 812
- `libnet_write` function, 814
- libpcap library, 788, 792–793
- Lightweight Directory Access Protocol, *see* LDAP
- lightweight process, 675
- Lin, H., 267, 952
- line buffered standard I/O stream, 402
- linefeed, *see* LF
- linger structure, 192–193, 921
 - definition of, 202
- link-local
 - address, 881
 - multicast group, 551
 - multicast scope, 552–553
 - unicast scope, 881
- Linux, 20, 22–23, 25, 33, 78, 98, 108, 127, 143, 162, 249, 257, 262, 346, 390, 538, 666, 737, 740, 787, 791–793, 797, 809–810, 815, 940
- `listen` function, 12–13, 37–38, 45, 101, 104–109, 120, 122, 126, 132, 140, 178, 208, 210, 213, 271, 320, 330, 339, 362, 373, 379, 622, 777, 826, 841, 915, 924
 - definition of, 104
- LISTEN state, 41, 104, 126–128, 379, 921
- `Listen` wrapper function, source code, 107
- listening socket, 53, 109
- LISTENQ constant, 13
 - definition of, 902
- LISTENQ environment variable, 107
- little-endian byte order, 77
- Liu, C., 304, 349, 947
- LLADDR macro, definition of, 486
- local area network, *see* LAN
- `/local` service, 936
- `localtime` function, 685
- `localtime_r` function, 685
- LOG_ALERT constant, 366
- LOG_AUTH constant, 366
- LOG_AUTHPRIV constant, 366
- LOG_CONS constant, 367
- LOG_CRIT constant, 366
- LOG_CRON constant, 366
- LOG_DAEMON constant, 366, 380
- LOG_DEBUG constant, 366
- LOG_EMERG constant, 366
- LOG_ERR constant, 366, 910
- LOG_FTP constant, 366
- LOG_INFO constant, 366, 910
- LOG_KERN constant, 366
- LOG_LOCAL0 constant, 366
- LOG_LOCAL1 constant, 366
- LOG_LOCAL2 constant, 366
- LOG_LOCAL3 constant, 366
- LOG_LOCAL4 constant, 366
- LOG_LOCAL5 constant, 366
- LOG_LOCAL6 constant, 366
- LOG_LOCAL7 constant, 366
- LOG_LPR constant, 366
- LOG_MAIL constant, 366
- LOG_NDELAY constant, 367
- LOG_NEWS constant, 366
- LOG_NOTICE constant, 365–366, 380
- LOG_PERROR constant, 367
- LOG_PID constant, 367
- LOG_SYSLOG constant, 366
- LOG_USER constant, 366, 370, 379
- LOG_UUCP constant, 366
- LOG_WARNING constant, 366
- logger program, 367
- logical interface, 877
- login name, 372–373
- long-fat pipe, 39, 209, 236, 599, 950
 - definition of, 39

- loom program, xxiii
- loopback
 - address, 111, 365, 432, 876, 880
 - broadcast, 535
 - interface, 23, 792, 799, 809, 876–877
 - logical, 535, 564
 - multicast, 559, 563, 566, 570, 577
 - physical, 535, 564
 - routing, 173, 213, 509
- loose source and record route, *see* LSRR
- lost datagrams, UDP, 245–246
- lost duplicate, 43
- LP64, programming model, 28
- LPR, 62
- ls program, 414
- LSB (least significant bit), 77
- lseek function, 159, 400
- lsof program, 897
- LSRR (loose source and record route), 710–712

- M_DATA constant, 855–856, 866
- M_PCPROTO constant, 855–856, 860, 865
- M_PROTO constant, 855–856, 860, 863, 865, 867
- MAC (medium access control), 486, 879
- MacOS X, 22, 78, 108, 262, 473, 538, 921–922, 940
- mail exchange record, DNS, *see* MX
- main function, 825
- main thread, 676
- malloc function, 29, 246, 317, 320–321, 345, 425, 508, 536, 666, 684, 687–688, 707, 728
- management information base, *see* MIB
- Maslen, T. M., 346, 951
- MAX_IPOPTLEN constant, 714
- MAXFILES constant, 455
- maximum segment lifetime, *see* MSL
- maximum segment size, *see* MSS
- maximum transmission unit, *see* MTU
- maxlen member, 856
- MAXLINE constant, 7, 92, 592, 899
 - definition of, 902
- MBone (multicast backbone), 571, 885–887
- MCAST_BLOCK_SOURCE socket option, 193, 560, 562
- MCAST_JOIN_GROUP socket option, 193, 560, 562
- MCAST_JOIN_SOURCE_GROUP socket option, 193, 560
- MCAST_LEAVE_GROUP socket option, 193, 560–561
- MCAST_LEAVE_SOURCE_GROUP socket option, 193, 560
- MCAST_UNBLOCK_SOURCE socket option, 193, 560
- mcast_block_source function, 565–569
 - definition of, 565
- mcast_get_if function, 565–569
 - definition of, 565
- mcast_get_loop function, 565–569
 - definition of, 565
- mcast_get_ttl function, 565–569
 - definition of, 565
- mcast_join function, 561, 565–569, 572, 577, 582
 - definition of, 565
 - source code, 567
- mcast_join_source_group function, 565–569
 - definition of, 565
- mcast_leave function, 561, 565–569
 - definition of, 565
- mcast_leave_source_group function, 565–569
 - definition of, 565
- mcast_set_if function, 565–569, 585
 - definition of, 565
- mcast_set_loop function, 565–569, 577
 - definition of, 565
 - source code, 570
- mcast_set_ttl function, 565–569
 - definition of, 565
- mcast_unblock_source function, 565–569
 - definition of, 565
- McCann, J., xxii, 28, 56, 71, 216, 346–347, 504, 949, 951
- McCanne, S., 788, 790, 896, 951
- McDonald, D. L., 511, 519, 951
- McKusick, M. K., 20, 737, 951
- medium access control, *see* MAC
- memcmp function, 80–81, 246
 - definition of, 81
- memcpy function, 80–81, 860, 930
 - definition of, 81
- memmove function, 81, 930
- memory leak, 345
- memset function, 8, 80–81, 901
 - definition of, 81
- Mendez, T., 529, 952
- message
 - boundaries, 31
 - high-priority, STREAMS, 183, 854
 - normal, STREAMS, 183, 854
 - priority band, STREAMS, 183, 854
 - types, ICMPv4, 883
 - types, ICMPv6, 884
 - types, STREAMS, 854–855
- message-based interface, 858
- meter function, 830
- Metz, C. W., xxii, 360, 511, 519, 947, 951
- Meyer, D., 552–553, 951
- MF (more fragments flag, IP header), 871
- MIB (management information base), 496
- Milliken, W., 529, 952
- Mills, D. L., 579, 951
- minimum link MTU, 55
- minimum reassembly buffer size, 57
- mkfifo function, 421

- mktemp function, 834
- mmap function, 26, 830, 836
- MODE_CLIENT constant, 582
- modules, STREAMS, 852
- Mogul, J. C., 56, 875, 951
- monitor mode, 787
- Moore, K., 889, 948
- more fragments flag, IP header, *see* MF
- MORE_flag member, 867
- MORECTL constant, 857
- MOREDATA constant, 857
- Morneault, K., 36, 280, 954
- Moskowitz, B., 876, 952
- most significant bit, *see* MSB
- mrouted program, 735, 886–887
- MRP (multicast routing protocol), 556
- MSB (most significant bit), 77
- MSG_ABORT constant, 225, 301
- MSG_ADDR_OVER constant, 225, 271
- MSG_ANY constant, 857
- MSG_BAND constant, 857
- MSG_BCAST constant, 391–392
- MSG_CTRUNC constant, 391–392
- MSG_DONTROUTE constant, 199, 388, 391
- MSG_DONTWAIT constant, 388, 391, 398
- MSG_EOF constant, 225, 301
- MSG_EOR constant, 277, 285, 389, 391–392, 432, 936
- MSG_HIPRI constant, 857
- MSG_MCAST constant, 391–392
- MSG_NOTIFICATION constant, 225, 277, 279–280, 290, 391–392
- MSG_OOB constant, 207, 388, 391–392, 646–648, 650–651, 654, 657, 659, 662
- MSG_PEEK constant, 388, 391, 398–399, 409, 421, 895, 934
- MSG_PR_BUFFER constant, 225
- MSG_PR_SCTP constant, 225
- MSG_TRUNC constant, 391–392, 594
- MSG_UNORDERED constant, 225, 629
- MSG_WAITALL constant, 90, 388, 391, 435
- msg_accrightrights member, 390, 421, 425, 427
- msg_accrightrightslen member, 390
- msg_control member, 390–391, 394–396, 398, 421, 425, 590
- msg_controllen member, 77, 390–392, 394–396, 398
- msg_flags member, 225, 277, 280, 285, 389–392, 394, 588, 590, 594, 936
- msg_iov member, 390–391
- msg_iovlen member, 390–391
- msg_name member, 390–391, 394
- msg_namelen member, 77, 390–391, 394, 590
- msg_hdr structure, 77, 277, 389–393, 395, 398, 421, 428, 588, 590, 594, 601, 729
 - definition of, 390
- MSL (maximum segment lifetime), 41, 43–44, 151, 203, 915
 - definition of, 43
- MSS (maximum segment size), 42, 57–60, 63, 208, 219, 237, 895, 914, 920–921
 - definition of, 38
 - option, TCP, 38
- MTU (maximum transmission unit), 18, 23, 25, 56–57, 59, 537–538, 595, 737, 772, 874, 884, 914
 - definition of, 55
 - discovery, path, definition of, 56
 - minimum link, 55
 - path, 59, 63, 219, 444, 771, 874, 921, 951
 - path, definition of, 56
- multicast, 549–585
 - address, 549–553
 - address, administratively scoped IPv4, 553
 - address, ethernet mapping, picture of, IPv4, 550
 - address, ethernet mapping, picture of, IPv6, 550
 - address, IPv4, 549–551
 - address, IPv6, 551–552
 - address, picture of, IPv6, 551
 - backbone, *see* MBone
 - filtering, imperfect, 555
 - group address, 549
 - group, all-hosts, 550
 - group, all-nodes, 552
 - group, all-routers, 550, 552
 - group ID, 549
 - group, link-local, 551
 - group, transient, 551
 - group, well-known, 551, 571
 - IP fragmentation and, 571
 - listener done, ICMPv6, 884
 - listener query, ICMPv6, 884
 - listener report, ICMPv6, 884
 - on WAN, 556–558
 - routing protocol, *see* MRP
 - scope, 360, 552–553
 - scope, admin-local, 552
 - scope, continent-local, 552
 - scope, global, 552–553
 - scope, interface-local, 552–553
 - scope, link-local, 552–553
 - scope, organization-local, 552–553
 - scope, region-local, 552
 - scope, site-local, 552–553
 - sending and receiving, 575–579
 - session, 553
 - session, SSM, 559
 - socket option, 559–564
 - versus broadcast, 553–556
 - versus unicast, 553
- multihomed, 52–54, 103, 122, 147, 247–248, 250, 262, 312, 314, 324, 532–533, 561, 582, 786, 796,

- 877, 925
- multihoming, 31
- multiplexor, STREAMS, 852–853
- mutex, 697–701
- MX (mail exchange record, DNS), 304, 308, 310, 349
- my_lock_init function, 833–834, 836
- my_lock_release function, 836
- my_lock_wait function, 836
- my_open function, 421, 423, 427
- my_read function, 92, 692
- mycat program, 421–422
- mydg_echo function, 609–611

- Nagle algorithm, 219–221, 229, 390, 402, 923, 928
 - definition of, 219
- name server, 305–306, 310, 361, 788, 793–794, 803, 811–812
- Narten, T., 551, 879, 949, 951
- neighbor advertisement, ICMPv6, 884
 - inverse, ICMPv6, 884
- neighbor discovery, 881
- neighbor solicitation, ICMPv6, 884
 - inverse, ICMPv6, 884
- Nemeth, E., 38, 951
- Net/1, 21, 718
- Net/2, 21, 737
- Net/3, 21, 388
- NET_RT_DUMP constant, 497
- NET_RT_FLAGS constant, 497–498
- NET_RT_IFLIST constant, 497–500
- net_rt_iflist function, 500, 502, 505–506, 508
- NetBIOS, 952
- NetBSD, 20–21
- netbuf structure, 856
- <netdb.h> header, 308, 315, 348
- netent structure, 348
- <net/if_arp.h> header, 481
- <net/if_dl.h> header, 486
- <net/if.h> header, 480, 504
- <netinet/icmp6.h> header, 740
- <netinet/in.h> header, 68, 71–72, 83, 103, 120, 616, 619, 736
- <netinet/ip_var.h> header, 714
- <netinet/udp_var.h> header, 499
- <net/pfkeyv2.h> header, 512
- <net/route.h> header, 483, 487, 489
- Netscape, 452, 461
- netstat program, 23–24, 31, 37, 40, 53, 63, 126–128, 141, 151, 237, 248, 258–259, 349, 379, 480, 484–485, 576, 612, 896–897, 917, 926
- Netware, 952
- network
 - byte order, 69, 79, 82, 110, 152, 311–312, 319, 737–738, 740, 918
 - interface tap, *see* NIT
 - topology, discovering, 23–25
 - virtual, 885–889
 - virtual terminal, *see* NVT
- Network File System, *see* NFS
- Network Information System, *see* NIS
- Network News Transfer Protocol, *see* NNTP
- Network Provider Interface, *see* NPI
- Network Time Protocol, *see* NTP
- new generic socket address structure, 72–73
- next header field, IPv6, 872
- next_pcap function, 808
- nfds_t datatype, 184
- NFS (Network File System), 62, 208, 213, 239, 596–597, 789
- NI_DGRAM constant, 340–341
- NI_NAMEREQD constant, 340, 350
- NI_NOFQDN constant, 340–341
- NI_NUMERICHOST constant, 340–341, 933
- NI_NUMERICSCOPE constant, 340–341
- NI_NUMERICSERV constant, 340–341, 933
- nibble, 304
- Nichols, K., 215, 870–871, 948, 952
- Nielsen, H. F., 294, 949
- NIS (Network Information System), 306
- NIT (network interface tap), 788, 793
- NNTP (Network News Transfer Protocol), 62
- no operation, *see* NOP
- NO_ADDRESS constant, 308
- NO_DATA constant, 308
- NO_RECOVERY constant, 308
- nonblocking
 - accept function, 461–463
 - connect function, 448–461
 - I/O, 88, 165, 234–235, 388, 398, 435–464, 468, 665, 669, 671, 919, 945
 - I/O model, 155–156
- nonlocal goto, 543, 803
- NOP (no operation), 709, 711–714, 718, 733
- Nordmark, E., 28, 216, 397, 719, 738, 744, 878, 880, 949, 952–953
- normal, STREAMS message, 183, 854
- notifications, SCTP, 625–629
- NPI (Network Provider Interface), 854, 954
- ntohl function, 79, 152, 918
 - definition of, 79
- ntohs function, 110
 - definition of, 79
- NTP (Network Time Protocol), 62, 530, 536, 561, 575, 585, 665–666, 672, 951
- ntpd function, 162
- ntpdata structure, 580
- ntp.h header, 580
- NVT (network virtual terminal), 916

- O_ASYNC constant, 234–235, 468, 664, 669
- O_NONBLOCK constant, 234–235, 468, 669

- O_RDONLY constant, 423
- O_SIGIO constant, 664
- octet, definition of, 80
- one-to-many SCTP interface model, 270–272
- one-to-one SCTP interface model, 269–270
- Ong, L., 36, 267, 952
- open
 - active, 37–38, 41, 45, 48, 53, 894
 - passive, 37, 41, 45, 48, 52–53, 894
 - shortest path first, routing protocol, *see* OSPF
 - simultaneous, 40–41
 - systems interconnection, *see* OSI
- open function, 135, 370, 415, 421, 423, 427, 790, 836
- Open Group, The, 27–28, 952
- Open Software Foundation, *see* OSF
- OPEN_MAX constant, 186
- open_output function, 799, 805, 812
- open_pcap function, 799, 801
- OpenBSD, 20–21, 737
- openfile program, 422–424, 427
- openlog function, 365–367, 370, 378
 - definition of, 367
- operating system, *see* OS
- OPT_length member, 863, 865
- OPT_offset member, 863, 865
- opt_val_str member, 194, 196
- optarg variable, 516
- opterr variable, 516
- optind variable, 516
- options
 - IPv4, 214, 709–711, 871
 - IPv6, *see* IPv6 extension headers
 - socket, 191–238
 - TCP, 38–39
- optopt variable, 516
- organization-local multicast scope, 552–553
- OS (operating system), 22
- OSF (Open Software Foundation), 27
- OSI (open systems interconnection), 18, 20, 68, 98, 389, 392, 395, 952
 - model, 18–19
- OSPF (open shortest path first, routing protocol), 62, 64, 735, 914
- Ostermann, S., 360, 947
- Otis, D., 36
- out-of-band
 - data, 130, 162, 164–166, 184, 188, 207, 234, 388, 392, 466, 645–662, 855
 - data mark, 648, 654
 - data, TCP, 645–653, 661–662
- output
 - SCTP, 60–61
 - TCP, 58–59
 - UDP, 59–60
- owner, socket, 234–236, 649, 664, 669
- oxymoron, 597
- packet
 - information, IPv4 receiving, 588–593
 - information, IPv6 receiving, 615–618
 - too big, ICMP, 56, 771, 884
- PACKET_ADD_MEMBERSHIP socket option, 792
- PACKET_MR_PROMISC socket option, 792
- parallel programming, 698
- parameter problem, ICMP, 720, 883–884
- partial delivery, SCTP, 622–625
- Partridge, C., 35, 255, 529, 599, 721, 753, 947–948, 950, 952
- passive
 - close, 39–41, 47–48
 - open, 37, 41, 45, 48, 52–53, 894
 - socket, 104
- PATH environment variable, 23, 113
- path MTU, 59, 63, 219, 444, 771, 874, 921, 951
 - definition of, 56
- path MTU discovery, definition of, 56
- pause function, 189, 362, 447, 658
- PAWS (protection against wrapped sequence numbers), 950
- Paxson, V., 35–36, 56, 208, 280, 948, 952, 954
- payload length field, IPv6, 872
- pcap_compile function, 789, 801
- pcap_datalink function, 801, 808
- pcap_lookupdev function, 799
- pcap_lookupnet function, 801
- pcap_next function, 808–809
- pcap_open_live function, 799, 809
- pcap_pkthdr structure, 808
 - definition of, 809
- pcap_setfilter function, 801, 809
- pcap_stats function, 811
- _PC_SOCKET_MAXBUF constant, 209
- pending error, 165, 199
- perfect filtering, 555
- Perkins, C., 571, 949
- Perkinson, M., 420
- pererror function, 370
- persistent connection, 825
- PF_KEY constant, 511–512
- PF_PACKET constant, 791–793
- pfmod STREAMS module, 790
- Phan, B. G., 511, 519, 951
- PID (process ID), 135, 234–236, 369, 467, 742
- piggybacking, 42
- PII (Protocol Independent Interfaces), 27
- Pike, R., 12, 951
- ping program, 25, 33, 62, 169, 209, 237, 265, 585, 733, 925, 945
 - implementation, 741–754
- ping.h header, 742
- Pink, S., 255, 952

- pipe function, 415, 421
- pipe, long-fat, 39, 209, 236, 599, 950
- pkey structure, 687–688, 690
- Plauger, P. J., 399, 952
- pointer record, DNS, *see* PTR
- Point-to-Point Protocol, *see* PPP
- poll function, 142, 145, 151, 153–154, 156, 163, 168, 182–187, 189, 320, 402–403, 409, 662, 770, 943
 - definition of, 182
- POLLERR constant, 183–184, 188
- pollfd structure, 183, 185–186, 403–404
 - definition of, 183
- <poll.h> header, 184
- POLLHUP constant, 183
- POLLIN constant, 183
- polling, 156, 161, 702
- POLLNVAL constant, 183
- POLLOUT constant, 183
- POLLPRI constant, 183
- POLLRDBAND constant, 183
- POLLRDNORM constant, 183, 186, 188
- POLLWRBAND constant, 183
- POLLWRNORM constant, 183
- port
 - chargen, 61, 189, 349, 380, 930, 934
 - daytime, 61–62
 - discard, 61
 - dynamic, 51
 - echo, 61–62, 380
 - ephemeral, 50–51, 53–54, 87, 99, 101–103, 111, 120, 122, 245–246, 250, 262, 341, 416, 613, 769, 772, 779, 915
 - mapper, RPC, 102
 - mirroring, 787
 - numbers, 50–52
 - numbers and concurrent server, 52–55
 - private, 51
 - registered, 51, 122
 - reserved, 51–52, 101, 111, 122, 213
 - stealing, 212, 350
 - time, 61
 - unreachable, ICMP, 249, 253, 257, 265, 534, 755, 761, 764, 771, 794, 815, 883–884, 925
 - well-known, 50
- Portable Operating System Interface, *see* POSIX
- POSIX, 26–27, 68–69, 75, 79, 98–99, 106, 120, 130, 133, 140, 153–154, 158–160, 162, 173, 181, 183–186, 202, 209, 234–235, 252–253, 315, 322, 346, 369, 390, 397, 411–412, 414–415, 421, 436, 448, 463, 465, 467, 516, 536, 539, 541, 543, 594, 654, 663–664, 669–670, 679, 685, 687, 705, 775, 833, 930
- POSIX.1, 685, 919, 950
 - definition of, 26
- POSIX.1b, 26, 950
- POSIX.1c, 26, 676, 950
- POSIX.1g, 27–29
 - definition of, 27
- POSIX.1i, 26, 950
- POSIX.2, 26, 28
- Postel, J. B., 34–35, 50–51, 213, 869, 875, 879, 882, 949, 951–953
- PPP (Point-to-Point Protocol), 55, 497, 808
- pr_cpu_time function, 824, 827
- prefix length, 874
- preforked server
 - distribution of connections to children, TCP, 830–831, 835
 - select function collisions, TCP, 831–832
 - TCP, 826–842
 - too many children, TCP, 830, 834
- prethreaded server, TCP, 844–849
- prifinfo program, 484, 500
- PRIM_type member, 860, 862–863, 865, 867
- print_sadb_msg function, 516, 522, 527
- printf function, calling from signal handler, 133
- priority band, STREAMS message, 183, 854
- private address, 876
- private port, 51
- proc structure, 829
- proc_v4 function, 747–749
- proc_v6 function, 747, 749–750
- process
 - daemon, 363–380
 - group ID, 234–236, 368, 467
 - group leader, 369
 - ID, *see* PID
 - lightweight, 675
- programming model
 - ILP32, 28
 - LP64, 28
- promiscuous, mode, 555, 787, 790, 792, 799–800
- protection against wrapped sequence numbers, *see* PAWS
- proto structure, 743, 745, 755, 757
- protocol
 - application, 4, 421
 - byte-stream, 9, 31, 34, 93, 98, 392, 415, 435, 661
 - dependence, 10, 244
 - field, IPv4, 871
 - independence, 10–11, 244
 - usage by common applications, 62
- Protocol Independent Interfaces, *see* PII
- protoent structure, 348
- ps program, 127, 129, 137
- pselect function, 153, 181–182, 185, 188, 541, 543, 704
 - definition of, 181
 - source code, 543
- pseudoheader, 216, 738, 806
- Pthread structure, 687–688

- PTHREAD_MUTEX_INITIALIZER constant, 700, 834, 836
- Pthread_mutex_lock wrapper function, source code, 12
- PTHREAD_PROCESS_PRIVATE constant, 836
- PTHREAD_PROCESS_SHARED constant, 835–836
- pthread_attr_t datatype, 677
- pthread_cond_broadcast function, 704
 - definition of, 704
- pthread_cond_signal function, 704, 847
 - definition of, 702
- pthread_cond_t datatype, 702
- pthread_cond_timedwait function, 704
 - definition of, 704
- pthread_cond_wait function, 703–704, 706, 847
 - definition of, 702
- pthread_create function, 676–679, 681, 683, 842
 - definition of, 677
- pthread_detach function, 676–679
 - definition of, 678
- pthread_exit function, 676–679
 - definition of, 678
- pthread_getspecific function, 688, 691–693
 - definition of, 691
- pthread_join function, 676–679, 696, 701, 705–706
 - definition of, 677
- pthread_key_create function, 687–688, 690–691
 - definition of, 690
- pthread_key_t datatype, 691
- pthread_mutexattr_t datatype, 836
- pthread_mutex_init function, 700, 836
- pthread_mutex_lock function, 845
 - definition of, 700
- pthread_mutex_t datatype, 700, 834, 836
- pthread_mutex_unlock function, 704, 845
 - definition of, 700
- pthread_once function, 688, 690–692
 - definition of, 690
- pthread_once_t datatype, 691
- pthread_self function, 676–679
 - definition of, 678
- pthread_setspecific function, 688, 691, 693
 - definition of, 691
- pthread_t datatype, 677
- <pthread.h> header, 679, 694
- PTR (pointer record, DNS), 304, 310, 331
- Pusateri, T., 550, 952
- putc_unlocked function, 685
- putchar_unlocked function, 685
- putmsg function, 852, 855–857, 860, 863, 867–868, 891
 - definition of, 856
- putpmsg function, 855, 857, 868
 - definition of, 857
- QSIZE constant, 666
- Quarterman, J. S., 20, 737, 951
- queue
 - completed connection, 104
 - incomplete connection, 104
 - STREAMS, 854
- queued data, 398–399
- queueing, signal, 132, 138, 670–671
- race condition, 237, 384, 538–547, 921
 - definition of, 538
- Rago, S. A., 851, 854–855, 952
- Rajahalme, J., 871, 952
- Ramakrishnan, K., 215, 870–871, 948, 952
- Ramalho, M., 285, 953
- rand function, 685
- rand_r function, 685
- RARP (Reverse Address Resolution Protocol), 34, 787, 789–790
- raw socket, 18, 31, 62, 97, 214–216, 411, 485, 492, 495, 735–786, 788, 791, 793–794, 805–807, 809, 884, 945
 - creating, 736
 - input, 739–741
 - output, 737–738
- read function, 7, 9, 11, 29–30, 88, 90, 92–93, 117, 123, 126, 134–135, 159, 167, 171, 174–175, 177, 180, 184, 188, 200–201, 205–206, 210, 240–241, 252–253, 256–257, 265, 381–382, 387–390, 395, 399–400, 408–409, 425, 429, 432, 435, 437, 439–441, 451, 458–459, 490, 492, 545, 650, 655–657, 665, 789–790, 809–810, 841, 852, 854, 856, 892, 914, 919, 923–924, 935–936
- read_cred function, 429
- read_fd function, 424–425, 428, 779, 841
 - source code, 426
- readable_conn function, 778–779
- readable_listen function, 777–778
- readable_timeo function, 385
 - source code, 385
- readable_v4 function, 781–782
- readable_v6 function, 784
- readdir function, 685
- readdir_r function, 685
- readline function, 88–93, 121, 125–126, 128, 133, 142, 144–145, 151, 168–169, 172, 188, 288, 680, 686, 688, 690–693, 707, 843, 899, 916, 919, 921, 923
 - definition of, 88
 - source code, 90–91, 693
- readline_destructor function, 691, 707
- readline_once function, 691–692, 707

- readlinebuf function, 92
- readline.c function, 92
- readloop function, 746, 752
- readn function, 88–93, 149–150, 388, 435, 918
 - definition of, 88
 - source code, 89
- readv function, 210, 381, 389–391, 395, 408, 435
 - definition of, 389
- realloc function, 623
- Real-time Transport Protocol, *see* RTP
- reassembly, 56, 870, 883–884, 914, 926
 - buffer size, minimum, 57
- rebooting of server host, crashing and, 144–145
- rec structure, 755
- receive timeout, BPF, 789
- receiving sender credentials, 429–431
- record boundaries, 9, 34, 93, 206, 415–416, 935
- record route, 711
- recv function, 90, 210, 241, 252, 381, 387–391, 395, 399, 408–409, 435, 594, 647, 650–651, 657–659, 662
 - definition of, 387
- recv_all function, 577
- recv_v4 function, 761–762, 765
- recv_v6 function, 761, 765
- recvfrom function, 68, 75, 134, 155–160, 210, 239–241, 243–249, 251–252, 256, 264–265, 307, 320, 335, 340, 350, 356, 359–361, 382–386, 388–391, 395, 399, 408, 419, 435, 536, 539, 541, 543–545, 574, 577, 582, 588, 590, 592, 594, 599, 601, 611, 614, 647, 664, 671–672, 761, 763, 765, 769, 792, 809–810, 924–926, 934, 945
 - definition of, 240
 - with a timeout, 383–386
- recvfrom_flags function, 588–589, 592–593
- recvmsg function, 68, 76–77, 210, 214–218, 224–225, 241, 251–252, 271, 277, 280, 285, 381, 389–395, 397, 408, 421, 425, 429, 435, 561, 588, 590, 592, 594, 601, 603–604, 615–619, 647, 722, 727, 729, 731–733, 936, 941
 - definition of, 390
 - receiving destination IP address, 588–593
 - receiving flags, 588–593
 - receiving interface index, 588–593
- redirect, ICMP, 485, 497, 883–884
- re-entrant, 83, 86, 92, 133, 341–346, 684–685
- reference count, descriptor, 117, 421
- Regina, N., xxiii
- region-local multicast scope, 552
- registered port, 51, 122
- Rekhter, Y., 876, 952
- reliable datagram service, 597–608
- remote procedure call, *see* RPC
- remote terminal protocol, *see* Telnet
- rename function, 366
- Request for Comments, *see* RFC
- RES_length member, 865
- RES_offset member, 865
- RES_USE_INET6 constant, 346
- res_init function, 349
- reserved port, 51–52, 101, 111, 122, 213
- reset flag, TCP header, *see* RST
- resolver, 305–306, 317, 346, 359–360, 362, 597, 879–880, 933
- resource discovery, 530
- resource record, DNS, *see* RR
- retransmission
 - ambiguity problem, definition of, 598
 - timeout, *see* RTO
- revents member, 183–185, 403
- Reverse Address Resolution Protocol, *see* RARP
- rewind function, 400
- Reynolds, J. K., 50–51, 953
- RFC (Request for Comments), 34, 914, 947
 - 768, 34, 952
 - 791, 869, 952
 - 792, 882, 952
 - 793, 35, 213, 952
 - 862, 61
 - 863, 61
 - 864, 61
 - 867, 61
 - 868, 61
 - 950, 875, 951
 - 1071, 753, 948
 - 1108, 950
 - 1112, 550, 564, 949
 - 1122, 43, 237, 247, 532, 576, 589, 877, 948
 - 1185, 44, 950
 - 1191, 56, 951
 - 1305, 579, 951
 - 1323, 35, 38–39, 236, 497, 599, 885, 950
 - 1337, 203, 948
 - 1349, 215, 870, 948
 - 1390, 550, 950
 - 1469, 550, 952
 - 1519, 874, 949
 - 1546, 529, 952
 - 1700, 50–51, 953
 - 1812, 772, 948
 - 1832, 150, 953
 - 1886, 304, 954
 - 1918, 876, 952
 - 1981, 56, 951
 - 2026, 28, 948
 - 2030, 579, 951
 - 2113, 710, 950
 - 2133, 361, 949
 - 2140, 294, 954
 - 2292, 732, 953
 - 2327, 571, 949

- 2365, 552–553, 951
- 2367, 511, 519, 951
- 2401, 511, 951
- 2402, 719, 951
- 2406, 719, 951
- 2409, 524, 949
- 2428, 360, 947
- 2460, 55, 216, 721, 726, 871, 873, 949
- 2463, 882, 948
- 2464, 551, 948
- 2467, 551, 948
- 2470, 551, 949
- 2471, 879, 949
- 2474, 215, 870–871, 948, 952
- 2553, 346–347, 949
- 2581, 35, 208, 948
- 2675, 57, 721, 948
- 2711, 721, 952
- 2719, 267, 952
- 2765, 880, 952
- 2893, 880, 949
- 2960, 36, 280, 954
- 2974, 571, 949
- 2988, 35, 952
- 3041, 879, 951
- 3056, 889, 948
- 3068, 889, 950
- 3152, 304, 948
- 3168, 215, 870–871, 948, 952
- 3232, 50, 953
- 3286, 36, 952
- 3306, 551, 949
- 3307, 552, 949
- 3309, 36
- 3376, 564, 948
- 3390, 35, 947
- 3484, 317, 949
- 3493, 28, 71, 216, 346–347, 504, 949
- 3513, 529, 877–879, 949
- 3542, 28, 216, 397, 719, 738, 744, 953
- 3587, 878, 949
- Host Requirements, 948
- obtaining, 914
- RIP (Routing Information Protocol, routing protocol), 57, 62, 535
- Ritchie, D. M., 851, 910, 951, 953
- rl_cnt member, 693
- rl_key function, 691
- rl_once function, 691
- rlim_cur member, 919
- rlim_max member, 919
- RLIMIT_NOFILE constant, 919
- Rline structure, 691–693
- Rlogin, 219–220, 308, 661–662
- rlogin program, 52
- rlogind program, 718–719, 733, 945
- road map, client/server examples, 16–18
- Rose, M. T., 315
- round robin, DNS, 822
- round-trip time, *see* RTT
- route program, 234, 483
- routed program, 199, 481, 530, 535
- router, 5
 - advertisement, ICMP, 735, 741, 883–884
 - alert, 721
 - solicitation, ICMP, 735, 883–884
- routing
 - header, IPv6, 725–731
 - hop count, 481
 - IP, 869
 - socket, 485–509
 - socket, datalink socket address structure, 486–487
 - socket, reading and writing, 487–495
 - socket, sysctl operations, 495–499
 - table operations, ioctl function, 483–484
- Routing Information Protocol, routing protocol, *see* RIP
- RPC (remote procedure call), 102, 150, 372, 597
 - DCE, 62
 - port mapper, 102
 - Sun, 9, 62
- RR (resource record, DNS), 304–305
- rresvport function, 52
- RS_HIPRI constant, 856–857, 860
- rsh program, 44, 52, 312, 340
- rshd program, 718–719
- RST (reset flag, TCP header), 44, 99–101, 107, 140, 142–143, 145, 167, 179, 184, 188–189, 200, 202–203, 207, 236, 256, 462–463, 789, 794, 916, 921, 938
- rt_msghdr structure, 487, 490–492
 - definition of, 488
- RTA_AUTHOR constant, 489
- RTA_BRD constant, 489
- RTA_DST constant, 489–490
- RTA_GATEWAY constant, 489
- RTA_GENMASK constant, 489
- RTA_IFA constant, 489
- RTA_IFP constant, 489
- RTA_NETMASK constant, 489
- RTAX_AUTHOR constant, 489
- RTAX_BRD constant, 489
- RTAX_DST constant, 489
- RTAX_GATEWAY constant, 489
- RTAX_GENMASK constant, 489
- RTAX_IFA constant, 489
- RTAX_IFP constant, 489, 506
- RTAX_MAX constant, 489, 493
- RTAX_NETMASK constant, 489
- rtrentry structure, 467, 483
- RTF_LLININFO constant, 497–498

- RTM_ADD constant, 487
- RTM_CHANGE constant, 487
- RTM_DELADDR constant, 487
- RTM_DELETE constant, 487
- RTM_DELMADDR constant, 487
- RTM_GET constant, 487, 489–490, 497
- RTM_IFANNOUNCE constant, 487
- RTM_IFINFO constant, 487, 498, 502, 505, 508
- RTM_LOCK constant, 487
- RTM_LOSING constant, 487
- RTM_MISS constant, 487
- RTM_NEWADDR constant, 487, 498, 502
- RTM_NEWMADDR constant, 487
- RTM_REDIRECT constant, 487
- RTM_RESOLVE constant, 487
- rtm_addrs member, 489–490, 492–493
- rtm_type member, 490
- RTO (retransmission timeout), 598–599, 604, 606–607
- RTP (Real-time Transport Protocol), 575
- RTT (round-trip time), 35, 105–106, 169–170, 209, 220, 237, 436, 445, 447, 461, 595, 597–608, 620, 742, 745, 749–750, 762, 923
- RTT_RTOCALC macro, 606
- rtt_info structure, 601
- rtt_init function, 601, 606
 - source code, 605
- rtt_minmax function, 606
 - source code, 605
- rtt_newpack function, 603, 606
 - source code, 606
- rtt_start function, 603, 607
 - source code, 606
- rtt_stop function, 604, 607
 - source code, 607
- rtt_timeout function, 604, 607
 - source code, 607
- rtt_ts function, 603–604, 606, 941
 - source code, 606
- Rubin, A. D., 108, 711, 948
- RUSAGE_CHILDREN constant, 824
- RUSAGE_SELF constant, 824
- Rytina, I., 36, 267, 280, 285, 952–954

- s6_addr member, 71
- SA (security association), 511
- SA macro, 9, 71
- s_addr member, 68–69
- s_aliases member, 311
- s_fixedpt member, 580
- s_name member, 311
- s_port member, 311
- s_proto member, 311
- SA_INTERRUPT constant, 131
- SA_RESTART constant, 131, 134, 162, 383
- sa_data member, 70, 482, 792
- sa_family member, 70–71, 482, 490, 494
- sa_family_t datatype, 69
- sa_handler member, 131
- sa_len member, 70, 493–494
- sa_mask member, 131–132
- sac_info member, 282
- SACK (selective acknowledgment), 61
- SADB (security association database), 511
- SADB_AALG_MD5HMAC constant, 518
- SADB_AALG_NONE constant, 518
- SADB_AALG_SHA1HMAC constant, 518
- SADB_ACQUIRE constant, 513
- SADB_ADD constant, 513, 519, 522
- SADB_DELETE constant, 513
- SADB_DUMP constant, 513
- SADB_EALG_3DESCBC constant, 518
- SADB_EALG_DESCBC constant, 518
- SADB_EALG_NONE constant, 518, 521
- SADB_EALG_NULL constant, 518
- SADB_EXPIRE constant, 513, 523
- SADB_EXT_ADDRESS_DST constant, 514, 519, 522
- SADB_EXT_ADDRESS_PROXY constant, 514, 519
- SADB_EXT_ADDRESS_SRC constant, 514, 519, 522
- SADB_EXT_IDENTITY_DST constant, 514
- SADB_EXT_IDENTITY_SRC constant, 514
- SADB_EXT_KEY_AUTH constant, 514, 519, 522
- SADB_EXT_KEY_ENCRYPT constant, 514, 519
- SADB_EXT_LIFETIME_CURRENT constant, 514
- SADB_EXT_LIFETIME_HARD constant, 514
- SADB_EXT_LIFETIME_SOFT constant, 514
- SADB_EXT_PROPOSAL constant, 514
- SADB_EXT_SA constant, 514
- SADB_EXT_SENSITIVITY constant, 514
- SADB_EXT_SPIRANGE constant, 514
- SADB_EXT_SUPPORTED_AUTH constant, 514
- SADB_EXT_SUPPORTED_ENCRYPT constant, 514
- SADB_FLUSH constant, 513
- SADB_GET constant, 513
- SADB_GETSPI constant, 513
- SADB_LIFETIME_CURRENT constant, 523
- SADB_LIFETIME_HARD constant, 523
- SADB_LIFETIME_SOFT constant, 523
- SADB_REGISTER constant, 513
- SADB_SAFLAGS_PFS constant, 519
- SADB_SASTATE_DEAD constant, 518
- SADB_SASTATE_DYING constant, 518
- SADB_SASTATE_LARVAL constant, 518
- SADB_SASTATE_MATURE constant, 518, 521
- SADB_SATYPE_AH constant, 513–514
- SADB_SATYPE_ESP constant, 513–514, 524
- SADB_SATYPE_MIP constant, 513
- SADB_SATYPE_OSPFV2 constant, 513
- SADB_SATYPE_RIPV2 constant, 513–514
- SADB_SATYPE_RSVP constant, 513
- SADB_UPDATE constant, 513
- sadb_address structure, 514, 519

- definition of, 519
- sadb_address_exttype member, 519
- sadb_address_len member, 519
- sadb_address_prefixlen member, 519
- sadb_address_proto member, 519
- sadb_address_reserved member, 519
- sadb_alg structure, 524
 - definition of, 524
- sadb_alg_id member, 524
- sadb_alg_ivlen member, 524
- sadb_alg_maxbits member, 524
- sadb_alg_minbits member, 524
- sadb_dump function, 516
- sadb_ident structure, 514
- sadb_key structure, 514, 519
 - definition of, 519
- sadb_key_bits member, 519
- sadb_key_exttype member, 519
- sadb_key_len member, 519
- sadb_lifetime structure, 514
 - definition of, 523
- sadb_lifetime_addtime member, 523
- sadb_lifetime_allocations member, 523
- sadb_lifetime_bytes member, 523
- sadb_lifetime_exttype member, 523
- sadb_lifetime_len member, 523
- sadb_lifetime_usetime member, 523
- sadb_msg structure, 512
 - definition of, 513
- sadb_msg_errno member, 513
- sadb_msg_len member, 513, 521
- sadb_msg_pid member, 513
- sadb_msg_reserved member, 513
- sadb_msg_satype member, 513
- sadb_msg_seq member, 513
- sadb_msg_type member, 512–513
- sadb_msg_version member, 513
- sadb_prop structure, 514
- sadb_sa structure, 514, 517
 - definition of, 518
- sadb_sa_auth member, 518
- sadb_sa_encrypt member, 518
- sadb_sa_exttype member, 518
- sadb_sa_flags member, 518
- sadb_sa_len member, 518
- sadb_sa_replay member, 518
- sadb_sa_reply member, 518
- sadb_sa_spi member, 518, 521
- sadb_sa_state member, 518
- sadb_sens structure, 514
- sadb_spirange structure, 514
- sadb_supported structure, 514, 524
 - definition of, 524
- sadb_supported_exttype member, 524
- sadb_supported_len member, 524
- Salus, P. H., 30, 953
- sanity check, 536
- SAP (Session Announcement Protocol), 571, 573–574
- sasoc_asocmaxrxt member, 222–223, 639
- sasoc_assoc_id member, 222–223
- sasoc_cookie_life member, 222–223
- sasoc_local_rwnd member, 222–223
- sasoc_number_peer_destinations member, 222–223
- sasoc_peer_rwnd member, 222–223
- scatter read, 389
- scheduling latency, 162
- Schimmel, C., 830, 953
- Schwartz, A., 15, 949
- Schwartz, D., xxii
- Schwarzbauer, H., 36, 267, 280, 952, 954
- SCM_CREDS socket option, 395
 - ancillary data, picture of, 397
- SCM_RIGHTS socket option, 395
 - ancillary data, picture of, 397
- scope
 - admin-local multicast, 552
 - continent-local multicast, 552
 - global multicast, 552–553
 - global unicast, 878
 - interface-local multicast, 552–553
 - link-local multicast, 552–553
 - link-local unicast, 881
 - multicast, 360, 552–553
 - organization-local multicast, 552–553
 - region-local multicast, 552
 - site-local multicast, 552–553
 - site-local unicast, 881
- _SC_OPEN_MAX constant, 186
- script program, 699
- SCTP (Stream Control Transmission Protocol), 33, 36–37
 - address information, 631–635
 - association autoclose, 621–622
 - connection establishment, 44–50
 - connection termination, 44–50
 - four-way handshake, 45–46
 - heartbeat mechanism, 636–637
 - implementation, KAME, 299
 - interface model, converting, 637–639
 - interface model, one-to-many, 270–272
 - interface model, one-to-one, 269–270
 - interface models, 268–272
 - introduction, TCP, UDP, and, 31–64
 - notifications, 625–629
 - output, 60–61
 - partial delivery, 622–625
 - performance tuning, 639–641
 - socket, 267–286, 621–643
 - socket option, 222–233
 - state transition diagram, 47–49

- unordered data, 629
 - versus TCP, 641–642
 - watching the packets, 49
- SCTP_ACTIVE constant, 227
- SCTP_ADAPTION_INDICATION constant, 285
- SCTP_ADAPTION_LAYER socket option, 194, 222, 285
- SCTP_ADDR_ADDED constant, 283
- SCTP_ADDR_AVAILABLE constant, 283
- SCTP_ADDR_CONFIRMED constant, 283
- SCTP_ADDR_MADE_PRIM constant, 283
- SCTP_ADDR_REMOVED constant, 283
- SCTP_ADDR_UNCONFIRMED constant, 227
- SCTP_ADDR_UNREACHABLE constant, 283
- SCTP_ASSOC_CHANGE constant, 281
- SCTP_ASSOCINFO socket option, 222–223
- SCTP_AUTOCLOSE socket option, 194, 223, 622
- SCTP_BINDX_ADD_ADDR constant, 273–274
- SCTP_BINDX_REM_ADDR constant, 273–274
- SCTP_CANT_STR_ASSOC constant, 282
- SCTP_CLOSED constant, 233
- SCTP_COMM_LOST constant, 282
- SCTP_COMM_UP constant, 281, 633
- SCTP_COOKIE_ECHOED constant, 233
- SCTP_COOKIE_WAIT constant, 233
- SCTP_DATA_SENT constant, 284
- SCTP_DATA_UNSENT constant, 284
- SCTP_DEFAULT_SEND_PARAM socket option, 194, 224–225
- SCTP_DISABLE_FRAGMENTS socket option, 194, 225
- SCTP_ESTABLISHED constant, 233
- SCTP_EVENTS socket option, 194, 225–226, 271, 277, 280–281
- SCTP_GET_PEER_ADDR_INFO socket option, 194, 222, 226–227
- SCTP_INACTIVE constant, 227
- SCTP_INITMSG socket option, 194, 228
- SCTP_ISSUE_HB constant, 230, 636–637
- SCTP_I_WANT_MAPPED_V4_ADDR socket option, 194, 227
- SCTP_MAXBURST socket option, 194, 228
- SCTP_MAXSEG socket option, 57, 194, 229, 233, 236, 269, 928
- SCTP_NODELAY socket option, 194, 229, 236, 269, 928
- SCTP_NO_HB constant, 230, 636–637
- SCTP_PARTIAL_DELIVERY_ABORTED constant, 286
- SCTP_PARTIAL_DELIVERY_EVENT constant, 285
- SCTP_PEER_ADDR_CHANGE constant, 282
- SCTP_PEER_ADDR_PARAMS socket option, 194, 222, 229–230, 635
- SCTP_PRIMARY_ADDR socket option, 194, 222, 230
- SCTP_REMOTE_ERROR constant, 283
- SCTP_RESTART constant, 282, 633
- SCTP_RTOINFO socket option, 194, 222, 230–231
- SCTP_SEND_FAILED constant, 284
- SCTP_SET_PEER_ADDR_PARAMS socket option, 201
- SCTP_SET_PEER_PRIMARY_ADDR socket option, 194, 231–232
- SCTP_SHUTDOWN_ACK_SENT constant, 233
- SCTP_SHUTDOWN_COMP constant, 282
- SCTP_SHUTDOWN_EVENT constant, 284
- SCTP_SHUTDOWN_PENDING constant, 233
- SCTP_SHUTDOWN_RECEIVED constant, 233
- SCTP_SHUTDOWN_SENT constant, 233
- SCTP_STATUS socket option, 194, 222, 232–233, 278, 290
- sctp_adaption_event structure, definition of, 285
- sctp_adaption_layer_event member, 226
- sctp_address_event member, 226
- sctp_assoc_change structure, definition of, 281
- sctp_association_event member, 226
- sctp_assocparams structure, 222
 - definition of, 222
- sctp_assoc_t datatype, 271
- sctp_bind_arg_list function, 630–631
- sctp_bindx function, 272–274, 286, 630–631
 - definition of, 272
- sctp_check_notification function, 633
- sctp_connectx function, 274, 286
 - definition of, 274
- sctp_data_io_event member, 226, 271, 277, 280, 288
- sctp_event_subscribe structure, 225–226
 - definition of, 226
- sctp_freeladdrs function, 276, 633
 - definition of, 276
- sctp_freepaddrs function, 275, 633
 - definition of, 275
- sctp_getladdrs function, 275–276, 286, 633–634
 - definition of, 275
- sctp_get_no_strms function, 290
- sctp_getpaddrs function, 275, 286, 633–634
 - definition of, 275
- sctp_initmsg structure, 228, 299
 - definition of, 228
- sctp_notification structure, definition of, 281
- sctp_opt_info function, 222, 225–226, 230, 232, 278, 635
- sctp_paddr_change structure, definition of, 283
- sctp_paddrinfo structure, 226
 - definition of, 226
- sctp_paddrparams structure, 229, 637

- definition of, 229
- sctp_partial_delivery_event member, 226
- sctp_pdapi_event structure, definition of, 286
- sctp_peeloff function, 271–272, 286, 638–639, 643, 926–927
- sctp_peer_error_event member, 226
- sctp_print_addresses function, 633–634
- sctp_print_notification function, 628
- sctp_recvmsg function, 224–225, 271, 277, 280, 285–286, 288, 623, 927
- sctp_remote_error structure, definition of, 283
- sctp_rtinfo structure, 230
 - definition of, 231
- sctp_send_failed structure, definition of, 284
- sctp_send_failure_event member, 226
- sctp_sendmsg function, 224–225, 271, 276–277, 286, 288, 293, 295, 298, 301, 927
 - definition of, 276
- sctp_sendto function, 271
- sctp_setpeerprim structure, 231
 - definition of, 231
- sctp_setprim structure, 230
 - definition of, 230
- sctp_shutdown_event member, 226
- sctp_shutdown_event structure, definition of, 285
- sctp_sndrcvinfo structure, 224–225, 271, 277, 280, 288, 290, 292, 300, 642
 - definition of, 224
- sctp_status structure, 232
 - definition of, 232
- sctp_tlv structure, definition of, 280
- sctpstr_cli function, 290, 294, 629, 632
- sctpstr_cli_echoall function, 290, 294
- sdl_alen member, 486, 502, 939
- sdl_data member, 486–487
- sdl_family member, 486
- sdl_index member, 486
- sdl_len member, 486, 509
- sdl_nlen member, 486, 502, 939
- sdl_slen member, 486
- sdl_type member, 486
- SDP (Session Description Protocol), 571, 573–575
- sdr program, 571
- secure shell, *see* SSH
- security, association, *see* SA
 - association database, *see* SADB
 - association database, dumping, 514–517
 - association, dynamic, 524–528
 - association, static, 517–523
 - parameters index, *see* SPI
 - policy database, *see* SPDB
- SEEK_SET constant, 834
- segleft member, 727
- segment, TCP, 35
- select function, 76, 91, 134–135, 141–142, 145, 151, 153–154, 156–157, 160–169, 171–175, 177–185, 188–189, 199, 201–202, 209–210, 248, 262–263, 320, 364, 373, 375–377, 381–382, 385, 400, 402–406, 408–409, 437, 439–440, 445–446, 448–449, 451–452, 456–459, 461–463, 545, 547, 587, 606, 612, 614, 620, 647–648, 651–652, 655, 657, 661–662, 679, 694, 704, 770, 773–774, 777, 780, 817, 819, 831–832, 838, 841, 850, 919, 924, 938–939, 941
 - collisions, TCP preforked server, 831–832
 - definition of, 161
 - maximum number of descriptors, 166–167
 - TCP and UDP server, 262–264
 - when is a descriptor ready, 164–166
- selective acknowledgment, *see* SACK
- send function, 199, 210, 241, 252, 269, 271, 381, 387–389, 391, 395, 399, 408, 432, 435, 646, 648, 660, 662, 736–737, 936
 - definition of, 387
- send_all function, 577
- send_dns_query function, 803, 812, 814
- send_v4 function, 752, 754
- send_v6 function, 752, 754
- sendmail program, 349, 363, 377
- sendmsg function, 68, 76, 199, 210, 218, 225, 241, 269, 271, 276–277, 282, 300, 381, 389–395, 408, 420–421, 427–430, 435, 588, 601, 603, 615–617, 722, 727, 730–733, 737, 928
 - definition of, 390
- sendto function, 68, 74, 199, 210, 239–241, 243–245, 249–250, 252–253, 255–256, 264–265, 269, 271, 307, 317, 319, 335, 337, 356, 358–359, 382, 390–391, 395, 408, 415, 419, 435, 532, 535–536, 576–577, 599, 601, 611, 669, 736–737, 761, 806, 925
 - definition of, 240
- SEQ_number member, 865
- sequence number, UDP, 597
- Sequenced Packet Exchange, *see* SPX
- Serial Line Internet Protocol, *see* SLIP
- SERV_MAX_SCTP_STRM constant, 294
- SERV_PORT constant, 122, 125, 189, 242, 288, 599, 608
 - definition of, 902
- servent structure, 311, 348
 - definition of, 311
- server
 - concurrent, 15, 114–116
 - iterative, 15, 114, 243, 821–822
 - name, 305
 - not running, UDP, 248–249
 - preforked, 826
 - prethreaded, 844
 - processing time, *see* SPT

- Services, Differentiated, 870–871
- services, standard Internet, 61–62, 377, 893
- Session Announcement Protocol, *see* SAP
- session announcements, IP Multicast Infrastructure, 571–575
- Session Description Protocol, *see* SDP
- session leader, 369
- session, multicast, 553
 - SSM multicast, 559
- setgid function, 373
- setrlimit function, 189, 919
- setsid function, 369, 379
- setsockopt function, 191–194, 202, 218, 222, 230, 386, 554, 559, 567–570, 710–714, 717–719, 728, 733, 740, 761, 921, 945
 - definition of, 192
- setuid function, 373, 746, 799
- set-user-ID, 422, 742, 746, 799
- setvbuf function, 402
- Shah, H., 285, 953
- shallow copy, 321
- Sharp, C., 36, 267, 280, 952, 954
- SHUT_RD constant, 173, 189, 213, 279, 495, 901
- SHUT_RDWR constant, 173, 189, 280, 901, 919
- SHUT_WR constant, 173, 175, 205, 279, 901, 919
- shutdown function, 39, 117, 120, 171–173, 175, 188–189, 205–206, 213, 267, 278–279, 282, 401, 439, 446, 464, 495, 681, 819, 919, 938
 - definition of, 173
- shutdown of server host, 145
- SHUTDOWN-ACK-SENT state, 48
- SHUTDOWN-PENDING state, 47–48
- SHUTDOWN-RECEIVED state, 47–48
- SHUTDOWN-SENT state, 48
- SIG_DFL constant, 129–130, 935
- SIG_IGN constant, 129–130, 133, 143
- sig_alrm function, 601, 752, 759, 765, 803
- sig_chld function, 133, 138, 263, 823
- sigaction function, 129–132, 158
- sigaction structure, 131
- sigaddset function, 541, 669
- SIGALRM signal, 131, 342, 381, 383–384, 409, 536, 539, 541, 543, 545, 547, 601, 603, 620, 742, 745, 747, 752, 759, 765, 802–803
- SIGCHLD signal, 128–130, 132–135, 137–139, 141, 151, 262, 376–377, 446, 614, 823, 946
- sigemptyset function, 541
- Sigfunc datatype, 131
- SIGHUP signal, 364, 369–370, 379, 669, 671–672
- SIGINT signal, 181–182, 257, 370, 823, 827, 830, 837, 842, 846
- SIGIO signal, 129, 157–158, 200, 234–235, 467–468, 663–666, 669–672, 895
 - TCP and, 664–665
 - UDP and, 664
- SIGKILL signal, 129, 145
- siglongjmp function, 383, 543–545, 601, 603–604, 620, 802–803
- signal, 129–132
 - action, 129
 - blocking, 131–132, 539, 541, 543, 545, 669–671
 - catching, 129
 - definition of, 129
 - delivery, 131–133, 137, 539, 541, 545, 669–671, 946
 - disposition, 129–130, 133, 143, 676
 - generation, 541
 - handler, 129, 676
 - mask, 131, 181–182, 543, 669, 676, 802
 - queueing, 132, 138, 670–671
- Signal function, 130
- signal function, 130–131, 133–134, 137, 383, 664, 935
 - definition of, 131
 - source code, 130
- signal-driven I/O, 200, 234–235, 663–673
 - model, 157–158
- SIGPIPE signal, 142–143, 152, 165, 202, 916–917, 938
- SIGPOLL signal, 129, 663–664
- sigprocmask function, 132, 541, 669–670
- sigsetjmp function, 383, 543–545, 601, 603–604, 620, 802–803, 946
- SIGSTOP signal, 129
- sigsuspend function, 669
- SIGTERM signal, 145, 446–447, 827, 938
- SIGURG signal, 129–130, 234–235, 467, 647–649, 651, 655, 657–658, 661–662
- SIGWINCH signal, 370
- SIIT, 880, 952
- Simple Mail Transfer Protocol, *see* SMTP
- simple name, DNS, 303
- Simple Network Management Protocol, *see* SNMP
- Simple Network Time Protocol, *see* SNTP
- simultaneous
 - close, 40–41, 48
 - connections, 452–461
 - open, 40–41
- SIN6_LEN constant, 69, 71–72
- sin6_addr member, 71–72, 102, 480
- sin6_family member, 71, 254
- sin6_flowinfo member, 71–72, 872
- sin6_len member, 71
- sin6_port member, 71, 102
- sin6_scope_id member, 71–72
- sin_addr member, 68–70, 102, 480
- sin_family member, 68–69, 254
- sin_len member, 68
- sin_port member, 30, 68–69, 102
- sin_zero member, 68–70
- sinfo_assoc_id member, 224–225
- sinfo_context member, 224

- sinfo_cumtsn member, 224
- sinfo_flags member, 224, 300
- sinfo_pid member, 224
- sinfo_ppid member, 224
- sinfo_ssn member, 224
- sinfo_stream member, 224, 292
- sinfo_timetolive member, 224, 642
- sinfo_tsn member, 224
- sinit_max_attempts member, 228, 639–640
- sinit_max_init_timeo member, 228, 639–640
- sinit_max_instreams member, 228
- sinit_max_ostreams member, 299
- sinit_num_ostreams member, 228
- SIOCADDRT constant, 467, 483, 485
- SIOCATMARK constant, 234, 465–467, 654
- SIOCDDARP constant, 467, 482
- SIOCDELRT constant, 467, 483, 485
- SIOCGARP constant, 467, 482
- SIOCGIFADDR constant, 467, 480, 566, 568
- SIOCGIFBRDADDR constant, 467, 478, 481, 484
- SIOCGIFCONF constant, 234, 467–469, 474–475, 478, 480, 484, 500, 799
- SIOCGIFDSTADDR constant, 467, 478, 481
- SIOCGIFFLAGS constant, 467, 477, 480, 792
- SIOCGIFMETRIC constant, 467, 481
- SIOCGIFMTU constant, 538
- SIOCGIFNETMASK constant, 467, 481
- SIOCGIFNUM constant, 475, 484
- SIOCGPGRP constant, 234, 467–468
- SIOCGSTAMP constant, 666
- SIOCSARP constant, 467, 481
- SIOCSIFADDR constant, 467, 480
- SIOCSIFBRDADDR constant, 467, 481
- SIOCSIFDSTADDR constant, 467, 481
- SIOCSIFFLAGS constant, 467, 481, 792
- SIOCSIFMETRIC constant, 467, 481
- SIOCSIFNETMASK constant, 467, 481
- SIOCSPPGRP constant, 234, 467–468
- site-local
 - address, 881
 - multicast scope, 552–553
 - unicast scope, 881
- size_t datatype, 8, 29
- sizeof operator, 9, 412, 862
- Sklower, K., 315
- sleep function, 152, 163, 432, 539, 577, 648, 657, 660, 916, 935
- sleep_us function, 163
- SLIP (Serial Line Internet Protocol), 55, 808
- slow start, 461, 596, 950
- Smith, G. P., 325
- SMTP (Simple Mail Transfer Protocol), 9, 62, 938
- SNA (Systems Network Architecture), 952
- sn_header member, 281
- sn_type member, 281
- SNMP (Simple Network Management Protocol), 57, 62, 239, 496, 597
- snoop program, 896
- snprintf function, 15, 148, 423
- SNTP (Simple Network Time Protocol), 579–584, 951
- sntp_proc function, 582
- SO_ACCEPTCON socket option, 924
- SO_ACCEPTCONN socket option, 238
- SO_ATTACH_FILTER socket option, 792
- SO_BROADCAST socket option, 193, 198–199, 236, 532, 536, 786, 895, 945
- SO_BSDCOMPAT socket option, 249
- SO_DEBUG socket option, 193, 198–199, 237, 895, 922
- SO_DONTROUTE socket option, 193, 198–199, 388, 617, 895
- SO_ERROR socket option, 165, 193, 199–200, 236, 451
- SO_KEEPAALIVE socket option, 144–145, 151, 193, 198, 200–202, 236, 238, 895
- SO_LINGER socket option, 58, 117, 120, 140, 173, 193, 198, 202–207, 236–237, 282, 462, 895
- SO_OOBINLINE socket option, 193, 198, 207, 647–648, 654, 656, 662
- SO_RCVBUF socket option, 38, 193, 198, 207–209, 236, 243, 260, 623, 895, 925
- SO_RCVLOWAT socket option, 164, 193, 198, 209–210
- SO_RCVTIMEO socket option, 193, 210, 382, 386, 895
- SO_REUSEADDR socket option, 103, 193, 203, 210–213, 236–237, 262, 330, 339, 350, 362, 572, 577, 608, 610, 895, 922, 933
- SO_REUSEPORT socket option, 103, 193–194, 196, 210–213, 237, 895, 922
- SO_SNDBUF socket option, 58–60, 193, 198, 207–209, 223, 236, 895, 925
- SO_SNDLOWAT socket option, 165, 193, 198, 209–210
- SO_SNDTIMEO socket option, 193, 210, 382, 386, 895
- SO_TIMESTAMP socket option, 666
- SO_TYPE socket option, 193, 198, 213
- SO_USELOOPBACK socket option, 173, 193, 213, 509
- so_error variable, 199–200
- so_pgid member, 235
- so_socket function, 892–893
- so_timeo structure, 830
- sock program, 237, 265, 893–895, 925
 - options, 895
- SOCK_DGRAM constant, 97, 213, 242, 315, 319–320, 414, 791
- SOCK_PACKET constant, 33, 98, 787, 791–793, 797, 815
- SOCK_RAW constant, 97, 736, 791

- SOCK_SEQPACKET constant, 97–98, 319
- SOCK_STREAM constant, 7, 97–98, 198, 213, 319–320, 327, 330, 414–415
- sock_bind_wild function, 86–88, 772, 779
 - definition of, 87
- sock_cmp_addr function, 86–88
 - definition of, 87
- sock_cmp_port function, 86–88
 - definition of, 87
- sock_get_port function, 86–88
 - definition of, 87
- sock_masktop function, 493–494
- sock_ntop function, 86–88, 110, 120, 331, 340, 350, 482, 593, 933, 935, 941
 - definition of, 86
 - source code, 87
- sock_ntop_host function, 86–88, 493, 536
 - definition of, 87
- sock_opts structure, 194
- sock_set_addr function, 86–88, 932
 - definition of, 87
- sock_set_port function, 86–88, 761, 932
 - definition of, 87
- sock_set_wild function, 88, 581
 - definition of, 87
- sock_str_flag function, 197
- sockaddr structure, 9, 71–72, 193, 315, 477, 519, 522
 - definition of, 70
- sockaddr_dl structure, 489, 508, 591
 - definition of, 486
 - picture of, 73
- sockaddr_in structure, 8, 10, 68, 76, 227, 322, 358, 361, 477, 492, 494, 519, 772, 860, 915
 - definition of, 68
 - picture of, 73
- sockaddr_in6 structure, 32, 72, 76, 322, 477, 519, 617, 772, 872
 - definition of, 71
 - picture of, 73
- sockaddr_storage structure, 72–73, 120, 330, 561, 567, 772, 779
 - definition of, 72
 - picture of, 73
- sockaddr_un structure, 74, 76, 412, 416, 418–419
 - definition of, 412
 - picture of, 73
- sockargs function, 68
- socketmark function, 234, 465, 467, 654–660, 662
 - definition of, 654
 - source code, 654
- socket
 - active, 104
 - address structures, 67–74
 - address structure, comparison of, 73–74
 - address structure, generic, 70–71
 - address structure, IPv4, 68–70
 - address structure, IPv6, 71–72
 - address structure, new generic, 72–73
 - address structure, routing socket, datalink, 486–487
 - address structure, Unix domain, 412–414
 - datagram, 33
 - definition of, 8, 52
 - introduction, 67–93
 - key management, 511–528
 - owner, 234–236, 649, 664, 669
 - pair, definition of, 52
 - passive, 104
 - raw, 18, 31, 62, 97, 214–216, 411, 485, 492, 495, 735–786, 788, 791, 793–794, 805–807, 809, 884, 945
 - receive buffer, UDP, 260–261
 - routing, 485–509
 - SCTP, 267–286, 621–643
 - stream, 33
 - TCP, 95–120
 - timeout, 210, 381–386
 - UDP, 239–265, 587–620
 - Unix domain, 411–433
- Socket wrapper function, source code, 11
- socket function, 7–8, 10–11, 13, 30, 37–38, 45, 95–99, 101, 104, 109, 115, 120, 126, 140, 178, 210, 236, 242, 272, 275–276, 288, 314, 317, 319–320, 324, 327, 330, 361, 379, 416, 418–419, 421, 717, 736–739, 791–792, 829–831, 891–893, 913, 924, 941
 - definition of, 96
- socket option, 191–238
 - generic, 198–213
 - ICMPv6, 216
 - IPv4, 214–215
 - IPv6, 216–218
 - multicast, 559–564
 - obtaining default, 194–198
 - SCTP, 222–233
 - socket states, 198
 - TCP, 219–221
- socketpair function, 414–415, 420–421, 423, 545
 - definition of, 414
- sockets and standard I/O, 399–402
- sockets API, 8
- sockfd_to_family function, 119, 569
 - source code, 119
- sockfs filesystem, 892
- socklen_t datatype, 29, 69, 75, 915
- sockmod STREAMS module, 853, 858
- sockproto structure, 98
- sofree function, 140
- soft error, 100
- software interrupts, 129
- SOL_SOCKET constant, 395, 397

- Solaris, 20, 22, 51, 78, 100, 108, 111, 133–134, 169, 248, 257, 262, 306, 343, 345–346, 378, 380, 414, 444, 447, 451, 475, 477, 486, 536, 538, 564, 694–697, 700–701, 705, 718, 735, 772, 774, 793, 806, 818, 832, 836, 841, 892, 896–897, 913, 916, 919–920, 922
- solutions to exercises, 913–946
- soo_select function, 165
- soreadable function, 165
- sorwakeup function, 664
- source address
 - IPv4, 871
 - IPv6, 873
- source code
 - availability, xxii
 - conventions, 7
 - portability, interoperability, 361
- source quench, ICMP, 771–772, 883
- source routing
 - IPv4, 711–719
 - IPv6, 725–731
- source-specific multicast, *see* SSM
- sowriteable function, 165
- sp_family member, 98
- sp_protocol member, 98
- Spafford, E. H., 15, 949
- spc_state member, 283
- SPDB (security policy database), 512
- Spero, S., 294, 953
- SPI (security parameters index), 518
- spinfo_address member, 226–227
- spinfo_assoc_id member, 226
- spinfo_cwnd member, 226–227
- spinfo_mtu member, 226–227
- spinfo_rto member, 226–227
- spinfo_srtt member, 226–227
- spinfo_state member, 226–227
- spoofing, IP, 108, 948
- spp_address member, 229
- spp_assoc_id member, 229–230
- spp_hbinterval member, 229
- spp_hbpathmaxrxt member, 230
- spp_pathmaxrxt member, 229, 639
- sprintf function, 15
- SPT (server processing time), 595
- SPX (Sequenced Packet Exchange), 952
- Srinivasan, R., 150, 953
- srto_assoc_id member, 231
- srto_initial member, 231, 639
- srto_max member, 231, 639
- srto_max_init_timeo member, 640
- srto_min member, 231, 639
- ss_family member, 72–73
- ss_len member, 72–73
- sscanf function, 148–149
- SSH (secure shell), 22, 62
- SSM (source-specific multicast), 558–559, 950
- SSM multicast session, 559
- SSN (stream sequence number), 224
- ssp_addr member, 230
- ssp_assoc_id member, 230
- sspp_addr member, 230–231
- sspp_assoc_id function, 231
- sspp_assoc_id member, 231
- SSRR (strict source and record route), 710–712
- sstat_assoc_id member, 232
- sstat_fragmentation_point member, 232–233
- sstat_instrms member, 232
- sstat_outstrms member, 232–233
- sstat_penddata member, 232
- sstat_primary member, 232–233
- sstat_rwnd member, 232–233
- sstat_state member, 232
- sstat_unackdata member, 232–233
- Stallman, R. M., 26
- standard Internet services, 61–62, 377, 893
- standard I/O, 168, 344, 399–402, 409, 437, 935, 952
 - sockets and, 399–402
 - stream, 399
 - stream, fully buffered, 401
 - stream, line buffered, 402
 - stream, unbuffered, 402
- standards, Unix, 25–28
- start_connect function, 457–458
- state transition diagram, SCTP, 47–49
 - TCP, 40–41
- static qualifier, 92, 342
- stderr constant, 365
- <stdio.h> header, 402
- stealing, port, 212, 350
- Stevens, W. R., v, xx, 28, 35, 71, 208, 216, 346–347, 361, 397, 504, 719, 732, 738, 744, 948–949, 953–954
- Stewart, R. R., xxii, 36, 46, 49–50, 61, 203, 227, 280, 285, 641, 927, 953–954
- sticky options, IPv6, 731–732
- Stone, J., 36
- str_cli function, 125–126, 128, 136, 141–142, 147–148, 167, 169, 171–173, 175, 189, 401, 403, 406, 416, 437, 441–443, 446–447, 463, 679–681, 717
- str_echo function, 122–123, 126, 128, 147, 149, 263, 400–402, 416, 430, 638–639, 681, 707
- strbuf structure, 856, 866
 - definition of, 856
- strcat function, 15
- strcpy function, 15
- Stream Control Transmission Protocol, *see* SCTP
- stream
 - fully buffered standard I/O, 401
 - line buffered standard I/O, 402

- pipe, definition of, 415
- sequence number, *see* SSN
- socket, 33
- standard I/O, 399
- unbuffered standard I/O, 402
- STREAMS, 851–868
 - driver, 851
 - head, 852
 - ioctl function, 857–858
 - message, high-priority, 183, 854
 - message, normal, 183, 854
 - message, priority band, 183, 854
 - message types, 854–855
 - modules, 852
 - multiplexor, 852–853
 - queue, 854
- strerror function, 774–775, 910
- strict source and record route, *see* SSRR
- <string.h> header, 80
- strlcat function, 15
- strncpy function, 15
- strlen function, 916
- strncat function, 15
- strncpy function, 15, 413
- strong end system model, 103, 533
 - definition of, 247
- strtok function, 685
- strtok_r function, 685
- subnet
 - address, 875–876, 951
 - ID, 878
 - mask, 875
- sum.h header, 148
- Sun RPC, 9, 62
- SUN_LEN macro, 412–413, 902
- sun_family member, 412, 414
- sun_path member, 412–414, 416
- SunOS 4, 131, 788, 793
- SunOS 5, 22
- superuser, 111, 120, 213, 330, 363, 480, 482–483, 486, 492, 496, 498, 511, 579, 617, 736, 746, 759, 799, 862, 938
- SVR3 (System V Release 3), 161, 182–183, 851
- SVR4 (System V Release 4), 20, 34, 133, 140, 161–162, 164, 182–183, 262, 336, 415, 420, 463, 545, 594, 663–664, 772, 779, 787, 790, 815, 830, 832, 834, 836, 852, 855, 857, 868, 891–892
- SYN (synchronize sequence numbers flag, TCP header), 37–38, 44, 57, 99–100, 102, 104–105, 107, 208, 213, 219, 354–355, 357, 362, 416, 436, 710, 717–718, 789, 896, 917, 921
 - flooding, 108, 948
- SYN_RCVD state, 41, 104, 106
- SYN_SENT state, 40–41, 101
- synchronize sequence numbers flag, TCP header, *see* SYN
- synchronous, I/O, 160
- sysconf function, 186, 189
- sysctl function, 77, 482, 484–486, 495–500, 502, 509
 - definition of, 496
- sysctl operations, routing socket, 495–499
- <sys/errno.h> header, 13, 436, 677, 913
- <sys/event.h> header, 405
- <sys/ioctl.h> header, 466
- syslog function, 312, 340, 364–367, 369, 379–380, 718, 910, 934
 - definition of, 365
- syslogd program, 363–367, 370, 379
- <sys/param.h> header, 590
- <sys/select.h> header, 163, 189
- <sys/signal.h> header, 664
- <sys/socket.h> header, 69–70, 98, 202, 228, 396–397, 429, 497
- <sys/stropts.h> header, 184
- <sys/sysctl.h> header, 497
- system call
 - interrupted, 131, 134–135, 139
 - slow, 134
 - tracing, 891–893
 - versus function, 891
- System V Release 3, *see* SVR3
- System V Release 4, *see* SVR4
- Systems Network Architecture, *see* SNA
- <sys/tihdr.h> header, 858, 860
- <sys/types.h> header, 69, 166, 189
- <sys/uio.h> header, 389–390
- <sys/un.h> header, 412
- T_BIND_ACK constant, 860, 862
- T_bind_ack structure, definition of, 862
- T_BIND_REQ constant, 860
- T_bind_req structure, 860
 - definition of, 860
- T_CONN_CON constant, 865
- T_conn_con structure, definition of, 865
- T_conn_req structure, 863
 - definition of, 863
- T_DATA_IND constant, 866
- T_data_ind structure, 866
 - definition of, 867
- T_DISCON_IND constant, 865, 867
- T_discon_ind structure, definition of, 865
- T_ERROR_ACK constant, 860, 862, 864
- T_error_ack structure, definition of, 862
- T_OK_ACK constant, 864–865
- T_ok_ack structure, definition of, 865
- T_ORDREL_IND constant, 867
- T_ordrel_ind structure, definition of, 867
- T_ordrel_req structure, 867
 - definition of, 867
- T_primitives structure, 865

- t_info structure, 29
- t_opthdr structure, 29
- t_scalar_t datatype, 29
- t_uscalar_t datatype, 29
- TACCES error, 862
- TADDRBUSY error, 862
- Tanenbaum, A. S., 8, 954
- tar program, 26
- Taylor, I. L., xxii
- Taylor, T., 36, 280, 954
- tcflush function, 465
- tcgetattr function, 465
- TCP (Transmission Control Protocol), 33, 35–36
 - and SIGIO signal, 664–665
 - checksum, 753
 - client alternatives, 819–820
 - concurrent server, one child per client, 822–825
 - concurrent server, one thread per client, 842–843
 - connection establishment, 37–43
 - connection termination, 37–43
 - MSS option, 38
 - options, 38–39
 - out-of-band data, 645–653, 661–662
 - output, 58–59
 - preforked server, 826–842
 - preforked server, distribution of connections to children, 830–831, 835
 - preforked server, `select` function collisions, 831–832
 - preforked server, too many children, 830, 834
 - prethreaded server, 844–849
 - SCTP versus, 641–642
 - segment, 35
 - socket, 95–120
 - socket, connected, 109
 - socket option, 219–221
 - state transition diagram, 40–41
 - three-way handshake, 37–38
 - timestamp option, 39, 219, 950
 - UDP, and SCTP, introduction, 31–64
 - urgent mode, 645
 - urgent offset, 646
 - urgent pointer, 646
 - versus UDP, 594–597
 - watching the packets, 42–43
 - window, 35
 - window scale option, 38, 208, 950
- TCP_MAXSEG constant, 229
- TCP_MAXSEG socket option, 38, 194, 198, 219, 229, 236, 269, 895
- TCP_NODELAY socket option, 194, 198, 219–221, 236–237, 269, 390, 895, 923
- tcp_close function, 140
- tcp_connect function, 10, 319, 326–330, 337, 456, 696, 717
 - definition of, 326
 - source code, 327
- tcp_listen function, 330–335, 338–339, 378, 681, 823
 - definition of, 330
 - source code, 331
- tcpdump program, 32, 101, 142, 144, 189, 248, 256–257, 265, 443, 547, 566, 585, 661, 711, 718, 787, 789, 793, 800, 815, 893, 896–897, 921, 925–926
- TCP/IP big picture, 32–34
- TCP/IP Illustrated, Volume 1, *see* TCPv1
 - Volume 2, *see* TCPv2
 - Volume 3, *see* TCPv3
- TCPv1 (TCP/IP Illustrated, Volume 1), xx, 953
- TCPv2 (TCP/IP Illustrated, Volume 2), xx, 954
- TCPv3 (TCP/IP Illustrated, Volume 3), xx, 953
- Telnet (remote terminal protocol), 61–62, 151, 219–220, 662, 916
- telnet program, 93, 350
- termcap file, 169
- termination of server process, 141–142
- test networks and hosts, 22–25
- test programs, 896
- test_udp function, 799, 801
- TFTP (Trivial File Transfer Protocol), 57, 62, 213, 253, 587, 596–597, 613–614
- Thaler, D., 551, 949
- Thomas, M., 28, 216, 397, 719, 732, 738, 744, 936, 953
- Thomas, S., 551, 949
- Thomson, S., 28, 71, 216, 304, 346–347, 361, 504, 949, 954
- thr_join function, 695–697, 701, 705
- Thread structure, 844, 846
- thread_main function, 845, 847
- thread_make function, 845, 847
- <thread.h> header, 694
- threads, 675–707
 - argument passing, 682–685
 - attributes, 677
 - detached, 678
 - ID, 677
 - joinable, 678
- thread-safe, 86, 92, 346, 685–686, 691, 843
- thread-specific data, 92, 343, 346, 686–694
- three-way handshake, 37, 99, 104–109, 198, 208, 252, 256, 383, 436, 448–449, 451, 649, 656, 717–719, 826, 938
 - TCP, 37–38
- thundering herd, 830, 834, 846
- Thyagarajan, A., 564, 948
- time
 - absolute, 704
 - delta, 704
 - exceeded, ICMP, 755, 761, 764, 771, 883–884

- port, 61
- TIME_WAIT state, 41, 43–44, 62, 128, 151, 203, 207, 236–237, 339, 820, 897, 915–916, 921
- time function, 14–15
- time program, 447
- time_t datatype, 182
- timeout
 - BPF, receive, 789
 - connect function, 382–383
 - recvfrom function with a, 383–386
 - socket, 210, 381–386
 - UDP, 597
- timespec structure, 181–182, 405, 704–705, 903
 - definition of, 181
- timestamp option, TCP, 39, 219, 950
- timestamp request, ICMP, 739, 883
- time-to-live, *see* TTL
- timeval structure, 161–162, 181–182, 193, 210, 385–386, 405, 449, 606, 666, 704, 747, 941
 - definition of, 161
- timod STREAMS module, 853, 858
- tirdwr STREAMS module, 853–854
- TLI_error member, 862
- TLV (type, length, value), 720
- tmpnam function, 419, 685
- token ring, 34, 63, 199, 550–551, 914
- Torek, C., 213, 954
- TOS (type-of-service), 215, 870, 883, 948
- total length field, IPv4, 870
- Touch, J., 294, 954
- TPI (Transport Provider Interface), 854, 858–868, 954
 - tpi_bind function, 859–860, 863
 - tpi_close function, 860, 867
 - tpi_connect function, 860, 863
 - tpi_daytime.h header, 858
 - tpi_read function, 866
 - trace.h header, 755
 - traceloop function, 757, 759, 765
 - traceroute program, 33, 62, 214–215, 218, 617, 619
 - implementation, 755–768
 - traffic class, 618, 871
 - transaction time, 595
 - transient multicast group, 551
 - Transmission Control Protocol, *see* TCP
 - transport sequence number, *see* TSN
 - Transport Layer Interface, *see* TLI
 - Transport Provider Interface, *see* TPI
 - Trivial File Transfer Protocol, *see* TFTP
 - Troff, xxiii
 - trpt program, 199
 - truncation, UDP, datagram, 594
 - truss program, 892–893
 - TRY_AGAIN constant, 308
 - ts member, 809
 - TSN (transport sequence number), 224–225
 - TTL (time-to-live), 43, 215, 217–218, 552–553, 559, 563, 566, 575, 749, 755, 757, 759, 761–762, 772, 871, 873, 883, 886
 - ttynname function, 685
 - ttynname_r function, 685
 - Tuexen, M., 285, 953
 - tunnel, 885–889
 - automatic, 880
 - tv_nsec member, 181, 903
 - tv_sec member, 161–162, 181, 903
 - tv_sub function, 747
 - source code, 747
 - tv_usec member, 161, 181
 - type field, ICMP, 882
 - type, length, value, *see* TLV
 - type-of-service, *see* TOS
 - typo, 51
 - typographical conventions, 7
 - u_char datatype, 69, 559
 - u_int datatype, 69, 559
 - u_long datatype, 69
 - u_short datatype, 69
 - udata member, 405
 - UDP (User Datagram Protocol), 33–34
 - adding reliability to application, 597–608
 - and SCTP, introduction, TCP, 31–64
 - and SIGIO signal, 664
 - binding interface address, 608–612
 - checksum, 259, 497–499, 753, 793–814
 - concurrent server, 612–614
 - connect function, 252–255
 - datagram truncation, 594
 - determining outgoing interface, 261–262
 - lack of flow control, 257–261
 - lost datagrams, 245–246
 - output, 59–60
 - sequence number, 597
 - server not running, 248–249
 - socket, 239–265, 587–620
 - socket, connected, 252
 - socket receive buffer, 260–261
 - socket, unconnected, 252
 - TCP versus, 594–597
 - timeout, 597
 - verifying received response, 246–248
 - udp_check function, 808–809
 - udp_client function, 334–337, 572, 577, 580–582, 620, 935, 941
 - definition of, 334
 - source code, 335
 - udp_connect function, 337, 935
 - definition of, 337
 - source code, 337
 - udp_read function, 803, 806, 815

- udp_server function, 338–339, 933
 - definition of, 338
 - source code, 338
- udp_server_reuseaddr function, 933
- udp_write function, 805, 814
- udpcksum.h header, 795
- udpiphdr structure, 805
- ui_len member, 806
- ui_sum member, 806
- uint16_t datatype, 69
- uint32_t datatype, 69, 75
- uint8_t datatype, 68–69
- umask function, 414–415
- uname function, 577
- unbuffered standard I/O stream, 402
- unconnected UDP socket, 252
- unicast
 - broadcast versus, 532–535
 - multicast versus, 553
 - scope, global, 878
 - scope, link-local, 881
 - scope, site-local, 881
- uniform resource identifier, *see* URI
- uniform resource locator, *see* URL
- <unistd.h> header, 466, 516
- Unix 95, 27
- Unix 98, 30, 133, 184, 346, 685, 919, 952
 - definition of, 27
- Unix domain
 - differences in socket functions, 415–416
 - socket, 411–433
 - socket address structure, 412–414
- Unix International, 790, 854, 954
- Unix I/O, definition of, 399
- /unix service, 936
- Unix standard services, 52
- Unix standards, 25–28
- UNIX_error member, 862
- UNIXDG_PATH constant, 419
 - definition of, 902
- UNIXSTR_PATH constant, 416
 - definition of, 902
- Unix-to-Unix Copy, *see* UUCP
- UnixWare, 20, 257
- unlink function, 413–414, 416, 419, 432, 777, 834, 935
- unordered data, SCTP, 629
- unp_in_pktinfo structure, 588, 590, 901
 - definition of, 588
- unp.h header, 7–9, 13, 71, 86, 122, 125, 131, 242, 416, 419, 491, 588, 592, 679, 795, 899–904
 - source code, 899
- unpicmpd.h header, source code, 771
- unpifi.h header, 469
 - source code, 471
- unproute.h header, 491
- unprtt.h header, 601, 604, 606
 - source code, 604
- unpthread.h header, 679
- unspecified address, 876, 881
- URG (urgent pointer flag, TCP header), 646–647, 661
- urgent
 - mode, TCP, 645
 - offset, TCP, 646
 - pointer flag, TCP header, *see* URG
 - pointer, TCP, 646
- URI (uniform resource identifier), 575
- URL (uniform resource locator), 947
- User Datagram Protocol, *see* UDP
- user ID, 350, 374, 429, 431, 676, 746, 759, 799
- UTC (Coordinated Universal Time), 15, 61, 575, 582, 606, 704
- UUCP (Unix-to-Unix Copy), xv, 366
- value-result argument, 74–77, 109–111, 164, 183, 192, 197, 246, 389, 391, 394, 414, 469, 496, 499, 590, 710, 717, 856–857, 915, 932
- Varadhan, K., 874, 949
 - /var/adm/messages file, 379
 - /var/log/messages file, 370
 - /var/run/log file, 364, 367
- verifying received response, UDP, 246–248
- version number field, IP, 869, 871
- vi program, 26
- virtual network, 885–889
- virtual private network, *see* VPN
- Vixie, P. A., 308, 954
- void datatype, 9, 70–71, 88, 131, 677, 679, 681, 915
- volatile qualifier, 802
- VPN (virtual private network), 22
- wait function, 132–133, 135–139, 151, 613, 820, 827
 - definition of, 135
- waitpid function, 132–133, 135–139, 151, 376, 423, 677–678
 - definition of, 135
- wakeup_one function, 830
- WAN (wide area network), 5, 35, 219, 448, 549, 556–558, 596–597
- wandering duplicate, 43
- weak end system model, 103, 533, 608, 666, 916
 - definition of, 247
- web_child function, 825, 829, 843, 847
- web_client function, 842
- web.h header, 454
- Webstone benchmark, 820
- well-known
 - address, 52
 - multicast group, 551, 571

- port, 50
- WEXITSTATUS constant, 135, 423
- Whelan, E., 571, 949
- wide area network, *see* WAN
- WIFEXITED constant, 135
- wildcard address, 53, 87, 102, 122, 126, 147, 211, 322, 354–355, 357, 362, 373, 560, 562, 568, 581–582, 608, 610–611, 772, 779, 876, 881
- window scale option, TCP, 38, 208, 950
- window, TCP, 35
- Winner, G. T., xxii
- Wise, S., 315
- WNOHANG constant, 136, 138
- World Wide Web, *see* WWW
- wrapper function, 11–13
 - source code, Listen, 107
 - source code, Pthread_mutex_lock, 12
 - source code, Socket, 11
- Wright, G. R., xx, xxii–xxiii, 954
- writable_timeo function, 385
- write function, 15, 29–30, 58, 60, 88, 117, 135, 143, 152, 174, 200, 210, 221, 237, 240, 252–253, 255–256, 269, 271, 337, 344, 381–382, 387, 389–390, 395, 399, 403, 408, 432, 435, 437, 440, 442, 445, 458, 492, 495, 509, 648, 660, 665, 736–737, 790, 841, 854–856, 914, 916, 919, 923, 935, 938, 945
- write_fd function, 427–428, 773, 841
 - source code, 428
- write_get_cmd function, 457–459, 697
- writen function, 88–93, 121, 123, 125–126, 141–144, 149–151, 168–169, 175, 288, 400, 437, 458
 - definition of, 88
 - source code, 89
- writew function, 210, 221, 237, 381, 389–391, 395, 408, 435, 601, 737, 924
 - definition of, 389
- WWW (World Wide Web), 3, 106, 310, 448, 452–461, 818, 820, 822, 834

- XDR (external data representation), 150
- Xerox Network Systems, *see* XNS
- Xie, Q., 36, 46, 49–50, 61, 203, 227, 280, 285, 641, 927, 953–954
- xinetd program, 377
- XNS (Xerox Network Systems), 28, 98
- XNS (X/Open Networking Services), 27, 952
- X/Open, 27
 - Networking Services, *see* XNS
 - Portability Guide, *see* XPG
 - Transport Interface, *see* XTI
- XPG (X/Open Portability Guide), 27
- XTI (X/Open Transport Interface), xx, 27, 29

- yacc program, 26
- Yoakum, J., 36, 952
- Yu, J. Y., 874, 949

- Zhang, L., 36, 44, 280, 950, 954
- zombie, 129, 132–134, 137, 139