

Index

- k*-connectivity, 258
- k*-coverage, 364, 370
- k*-perimeter-covered, 370
- m*-ary modulation, 88, 104–105

- A priori, 76, 184, 205, 309, 427
- ABR, *see* Associativity-based routing
- Access delay, 112, 209, 214, 219
- Accountability, 422
- Accuracy, 3, 6, 10, 45, 49, 65, 70–72, 76–77, 203–206, 212, 217, 232, 236, 240–248, 322–324, 327, 342, 348–349, 352, 355, 422, 426, 430
- Ack implosion, 388–389
- Acknowledgment, 116–117, 153, 156, 346, 424
- ACPI, *see* Advanced configuration and power interface
- ACQUIRE, *see* Active query forwarding in sensor networks
- Active badge, 240–241
- Active link, 252
- Active node, 146, 252, 274, 375
- Active office, 240–241
- Active query forwarding in sensor networks, 336
- Activity, 11, 63, 73, 286, 320, 424
- Actuator, 2, 32, 60
- Ad hoc network design algorithm, 285
- Ad hoc on-demand distance vector, 265, 291
- Adaptive self-configuring sensor networks topologies, 287
- ADC, *see* Analog/Digital converter

- Additive white gaussian noise, 94–99, 103–105, 109
- Address-centric networking, 9–10
- Addressing, 71, 80, 128, 181–183, 286, 332, 398, 425
 - address allocation, 175, 182–184, 193
 - address representation, 182–183, 189, 193, 199
 - content-based, 181, 186, 194–195, 198–199
 - data-centric, 71, 194, 333
 - distributed assignment, 183, 187–189
 - geographic, 194, 198
 - location-based, 71
 - MAC address, 122, 128, 182–191, 198
 - random assignment, 187–188
 - uniqueness, 182–184, 190, 289
- Adjacent-channel interference, 94
- Admission control, 299, 403
- Advanced configuration and power interface, 37
- Advertisement, 197, 301, 314, 335, 424
- Agent-based networking, 69
- Aggregation, 9, 44, 68–71, 74, 77, 134, 197, 274, 280, 335, 341–357, 377, 398, 413–414, 422, 431
 - coding by ordering, 353
 - function, 68, 76, 341–348, 353–355
- AIDA, *see* Application-independent data aggregation
- ALOHA, 22, 116, 119, 129, 133, 257
- Alternating bit protocol, 154–156, 163, 173
- Altruist, 303
- Ambient intelligence, 1–3
- Amplitude shift keying, 22, 29–30, 89

- Analog/Digital converter, 25
- Anchor, 232–236, 241–249
- ANDA, *see* Ad hoc network design algorithm
- Angle of arrival, 202, 243
- Angulation, 234, 237, 248
- Antenna
- directed, 91
 - efficiency, 41, 87, 108
 - gain, 93
 - omnidirectional, 91
 - radiated power, 23, 29–31, 40, 87, 93, 102–105
- AODV, *see* Ad hoc on-demand distance vector
- API, *see* Application programming interface
- APIT, *see* Approximate point in triangle
- Application, 1–7, 11–13, 20, 61, 71, 114, 140, 362, 425
- classification, 50, 426
 - data-centric, 71
 - disaster relief, 3–4, 10
 - edge detection, 6, 60, 65, 429–432
 - environment control, 4
 - event classification, 6, 64
 - event detection, 6, 60, 63–64, 70, 231, 339
 - function approximation, 6, 60, 65, 70
 - periodic measurement, 6, 60, 68, 416
 - target tracking, 69, 350–351
 - tracking, 6, 12, 63–65, 70, 414, 425–428
- Application programming interface, 47, 77
- Application-independent data aggregation, 355
- Application-specific integrated circuit, 20
- Approximate point in triangle, 242
- Approximation, 43, 50, 65, 70, 187, 256–258, 272–273, 285, 298–299, 307–309, 312, 324, 342, 416, 432–433
- factor, 270–272, 307
 - quality, 8, 433
- Architecture, 10–13, 17–19, 25, 40–44, 47–48, 59–60, 140, 328
- ARQ, *see* Automatic repeat request, 48, 103, 151–154, 163
- ack implosion, 388–389
 - alternating bit, 154–156, 163, 173
 - checksum, 103, 153, 174, 398
 - feedback, 152–154, 158, 166, 403, 407
 - fragmentation and reassembly, 170–172
 - Goback N, 154–158
 - hybrid schemes, 163, 167
 - implicit acknowledgment, 379
 - instantaneous feedback with selective repeat, 157
 - intermediate checksums, 165, 172–174
 - negative acknowledgment, 153, 379, 389
 - packet combining, 165
 - packet formatting, 153
 - piggyback ack, 154–156
 - positive acknowledgment, 153, 379
 - postponing, 157
 - probing protocol, 158
 - recovery server, 389
 - retransmissions, 103, 149, 152–154, 157, 165, 172, 379
 - selective repeat, 153–158
 - semireliable, 155–157
 - sequence number, 153–154, 174, 178, 290, 390, 425
 - timer, 153–154, 382
 - windowed feedback with selective repeat, 156
- Art gallery problem, 376
- ASCENT, *see* Adaptive self-configuring sensor networks topologies
- ASIC, *see* Application-specific integrated circuit, 19–20
- ASK, *see* Amplitude shift keying, 22, 29–30, 89
- Associativity-based routing, 291
- Asymptotic stable throughput, 132
- Atmel ATmega, 21, 38, 54
- Attack, 422–425
- Attenuation, 23, 61, 88, 91–94, 108, 151, 235–236, 297
- Attribute value operation, 195–196
- Auto-configuration, 9
- Autocorrelation, 435
- Automatic repeat request, 48
- Availability, 285, 418, 422
- AVO, *see* Attribute value operation
- AWGN, *see* Additive white Gaussian noise
- Backbone, 252–253, 266, 270–276, 279, 282, 285–287
- Backoff algorithm, 116, 131
- Baseband processor, 24, 31
- Battery, 19, 32–34, 73, 119, 272, 296
- capacity, 3, 33–36, 146, 159, 273, 295, 298–299, 303
- BCH, *see* Bose-Chaudhuri-Hocquenghem
- BCH codes, 159–161

- Beaconed mode, 140–141, 220
- Belief, 350–351, 416
- BER, *see* Bit error rate
- Best-case coverage, 365, 372
- Binary exponential backoff, 116, 131
- Binary phase shift keying, 30, 89–90, 95, 98
- Binary symmetric channel, 97, 150, 155–157, 161–163, 168–173, 380, 383, 394
- Binding, 183, 194, 198
- BIP, *see* Broadcast incremental power
- Bit errors, 90, 95, 152
- Bit-error rate, 23, 88, 95, 101–105, 155, 161, 381
- Bit/symbol synchronization, 101
- Black hole, 424
- Block coding, 416
- Block coding FEC, 159–161
- Block delivery, 377–378, 389, 395
- Bluetooth, 44, 54–55, 87, 99, 114, 145, 280
- Boolean sensing model, 363, 366–369, 374–375
- Boundary, 6, 25, 275, 293, 363, 415, 429, 432–434
- BPSK, *see* Binary Phase Shift Keying, 30, 89–90, 95, 98
- Broadcast, 112, 115, 153, 190, 262, 270–274, 284, 291–293, 303–316, 326–328, 336, 340, 347–348, 388, 414–416, 420–422
 - broadcast incremental power, 308–315
 - cooperative multihop, 316
 - tree, 307, 310–313
- BSC, *see* Binary symmetric channel
- Busy-tone solution, 116, 131

- CADR, *see* Constrained anisotropic diffusion routing
- CAMP, *see* Core-assisted mesh protocol
- CAP, *see* Contention access period
- Capacity, 11–13, 86, 103, 109, 272, 287, 315, 420–422
- Carrier frequency, 21–24, 86
- Carrier sense, 23
- Carrier sense multiple access, 22, 113, 116, 119, 129–131, 134, 138, 142, 145–147, 394, 399
- Carrier synchronization, 100–101
- Carrier to interference ratio, 166
- CCK, *see* Complementary code keying

- CDMA, *see* Code division multiple access
 - CDMA codes, 99, 115
- CDMA codes, 99, 115
- CDS, *see* Connected dominating set
- Central processing unit, 19
- CGSR, *see* Clusterhead gateway switch routing
- Challenges, 7, 10, 201, 361
- Channel, 22–23, 30, 42, 85–86, 96–97, 102, 287
 - adjacent channel, 23
- Channel coding, 419
- Channel estimation
 - active estimator, 178
 - passive estimator, 178
- Checksum, 103, 153, 174, 398
 - checksum field, 153
 - header checksum, 152, 172
- Chip sequence, 31, 98
- CIR, *see* Carrier to interference ratio
- Class, 196
- Clear to send, 117–120, 125, 424
- Client/server, 77
- Clock adjustment, 203, 227
- Clock correction block, 206
- Clock skew, 204
- Clock-update discipline, 205–207
- Cluster, 124, 133–134, 223, 368, 374, 407, 431–432
- Clusterhead, 133–135, 194, 253, 274, 277–286, 351, 355, 378, 415, 425, 431, 434
- Clusterhead gateway switch routing, 291
- Clustering, 223, 274–288, 340, 355, 422
 - distributed gateway, 276
 - multihop cluster, 276, 281–282
 - multilayer, 283
 - multilevel, 348
 - passive, 284, 340
- CLUSTERPOW, 286
- CMMBCR, *see* Conditional max–min battery capacity routing
- Co-channel interference, 94
- CODA, *see* Congestion detection and avoidance, 402, 408–409
 - backpressure message, 408–409
 - closed-loop regulation, 408–409
 - open-loop hop-by-hop backpressure, 408
- Code, 42, 189, 418–421
- Code division multiple access, 99, 115, 128, 135, 265, 354

- Code rate, 41, 159–161, 166
- Codebook, 189–193, 420
- Codeword, 159, 189–194
- Coexistence, 87, 114
- Coherence bandwidth, 92, 97
- Collaboration, 2, 6, 9–10, 187
- Collaborative signal and information processing, 414
- Collision, 112–120, 127–129, 188, 192, 241, 252, 317, 321, 375, 400
- Collision avoidance, 119, 143
- Command, 51, 74, 77, 292
- Competitive ratio, 296, 299, 310
- Complementary code keying, 104
- Complexity, 40, 48, 66, 75, 78, 189, 256, 274, 282–284, 306, 309, 315, 415, 429
- Complexity penalized estimator, 431
- Component, 48–52, 74–75, 255, 258, 263, 270, 290, 431
- Composable, 68, 344, 347–348
- COMPOW, 263–264, 286
- Compression, 69, 76, 398, 414–416, 422, 433
- Concurrent programming, 45
- Conditional max–min battery capacity routing, 297
- Confidence, 246, 348–349, 415
 - interval, 415–416
- Confidentiality, 422
- Configuration, 51, 206
- Congestion, 22
- Congestion control, 361, 399–400, 408–411
 - bandwidth allocation, 411
 - CODA, 402, 408–409
 - detection, 402, 408
 - packet dropping, 403
 - rate control, 361, 400, 403
- Congestion detection and avoidance, 402, 408–409
- Connected dominating set, 272–273
- Connectivity, 375
- Consensus, 189, 199, 348
- Constrained anisotropic diffusion routing, 351–352
- Constraint length, 42, 160–161
- Content, 72, 194, 197, 333–334, 339–341, 344–345
 - content-based networking, 331–334
- Contention window, 116
- Contour, 429–433
- Controlled access, 422
- Controller, 18–19, 36–38, 240
- Convergecast, 282, 334–337, 340, 345–349, 352–354
- Convolutional coding FEC, 160–161, 167
- Coordinated universal time (UTC), 202–204, 207, 216
- Coordinator, 140–145, 187, 272
- Core-assisted mesh protocol, 314
- Correlation, 12, 69, 249, 334, 345, 353, 414–422, 433–435
- Coset, 419
- Cost, 13, 18, 24, 27, 32, 231, 236, 290, 298–311, 320, 340, 346–347, 352, 356
 - energy, 41, 298, 303, 309, 340, 351–352, 385
- COUGAR, 343
- Covariance, 348–351
- Coverage, 32, 66, 78, 241, 251, 255, 285, 288, 293, 296, 347
 - k*-perimeter-covered, 370
 - critical intensity, 368
 - determination, 369
 - measures, 364–369
 - perimeter-covered, 370
- Coverage measures
 - k*-coverage, 364, 370
 - area coverage, 364–368, 374–375
 - best-case coverage, 365, 372
 - detectability, 364–368, 374
 - detection reliability, 360
 - exposure, 365
 - full area coverage, 364, 375–376
 - maximal support path, 365
 - maximum breach path, 364, 372
 - node coverage, 364–368, 374–375
 - sensor field intensity, 364–365, 368–369
 - worst-case coverage, 364, 371–372
- CPM, *see* Code position modulation
- CPU, *see* Central processing unit
- CRC, *see* Cyclic redundancy check
- Cricket, 241
- Critical intensity, 368
- Cross-layer, 13, 48, 74, 265, 359, 421
- Cryptographic algorithms, 422–423
- CSD, *see* Cumulative sensing degree
- CSIP, *see* Collaborative signal and information processing
- CSMA, *see* Carrier sense multiple access, 22, 113, 116, 119, 124, 128–131, 134, 138, 142, 145–147, 394, 399
 - collision avoidance, 119, 143

- collision detection, 113–114
- contention window, 116
- nonpersistent CSMA, 116–117, 130, 146
- persistent CSMA, 116
- CTS, *see* Clear to send
- Cumulative sensing degree, 273
- Cycled receiver, 121, 129
 - listen period, 121–123, 126, 129
- Cyclic redundancy check, 48

- DAC, *see* Digital/Analog converter
- DAD, *see* Duplicate address detection
- DAG, *see* Directed acyclic graph
- DAML, *see* DARPA agent markup language
- DARPA agent markup language, 78
- Data
 - advertisement, 197, 301, 335
 - cache, 338
 - collection, 282, 328–329, 345, 354–355, 414–415
 - dissemination, 314–315, 335–337, 341, 355, 424
 - distribution, 292, 335–337, 414, 421
 - funneling, 353
 - integrity, 422
 - named data, 72, 194, 197, 333–337
 - rate, 11, 21–22, 27–30, 73, 88, 103–104, 265, 338, 415–416, 420
 - sink, 6, 279–280, 284, 301–302, 305, 328, 332, 341, 353–354
 - source, 6, 71, 302, 310, 332, 389–390
 - storage, 357
- Data-centric
 - addressing, 71, 194, 333
 - application, 71
 - networking, 10–12, 70–72, 80–81, 181, 186, 292, 305, 323, 331–336, 339–341, 350–352
 - interactions, 332
 - storage, 335, 355–357
- Data-centric networking
 - directed diffusion, 194–197, 337–341, 345, 395–396, 424–426
 - information-driven routing, 350–352
 - pull diffusion, 340
 - push diffusion, 339–340
- Data centric storage, 355
- Data link layer, 112, 149–153

- Database, 53, 72–73, 77, 274, 292, 327, 342–343, 357
 - execution plan, 343
- DBPSK, *see* Differential binary phase shift keying
- DC–DC conversion, 34
- DCF, *see* Distributed coordination function, 116, 146
- DCS, *see* Data centric storage, *see* Dynamic code scaling
- Decoder, 42, 152, 162, 166, 170, 417–420
 - energy consumption, 42, 160, 167
- Decoupling, 71, 332
- Delaunay triangulation, 260, 324, 372
- Delay spread, 92, 97–98
- Delivery probability, 155, 378–379, 385, 389
- Demand assignment protocols, 115, 119
 - central control protocols, 115
 - token-passing protocols, 115
- Demodulation, 22, 85, 88, 100
- Denial-of-service, 423
- Density, 243, 251, 255, 258, 265, 274, 430, 435
 - probability density, 213, 235, 247, 348, 417
- Dependability, 12
- Deployment, 7–8, 12–13, 66, 185, 189, 248, 252, 273, 362, 369, 374–376
 - redundant, 8, 12–13, 66, 252, 273
- Destination-sequenced distance vector, 291
- Desynchronization, 425
- Detectability, 364–368, 374
- Detection, 4, 8, 32, 183, 242, 425–426
 - coherent, 95, 100
 - noncoherent, 95, 101
- Detection reliability, 360
- DHCP, *see* Dynamic host configuration protocol
- DHT, *see* Distributed hash table
- Diffraction, 90–91, 151
- Digital signal processor, 19–20
- Digital/Analog converter, 25
- Direct sequence spread spectrum, 28–31, 99, 109
- Directed acyclic graph, 325
- Directed antennas, 315
- Directed diffusion, 194–197, 337–341, 345, 395–396, 424–426
 - pull diffusion, 340
 - push diffusion, 339–340
- Directionality, 362

- DISCUS, *see* Distributed source coding using syndromes
- Disk graph model, 255–257
- Distance routing effect algorithm for mobility, 317, 327
- Distributed coordination function, 116, 146
- Distributed hash tables, 71, 356
- Distributed mobility-adaptive clustering, 128
- Distributed multihop LTS, 211–212
- Distributed signal processing, 414
- Distributed source coding using syndromes, 419–420
- Distributed system, 3, 203
- Diversity, 102, 108, 377
 - explicit, 102
 - implicit, 102
 - receive, 102, 108
- DLL, *see* Data link layer
- DMAC, *see* Distributed mobility-adaptive clustering
- DMCS, *see* Dynamic modulation-code scaling
- DMS, *see* Dynamic modulation scaling
- Dominating set, 252–253, 266–276, 281–286, 304
- Doppler fading, 90–91
- DPM, *see* Dynamic power management
- DQPSK, *see* Differential quaternary phase shift keying
- DREAM, *see* Distance routing effect algorithm for mobility
- Drift, 30
- Drift rate, 203–205, 210, 221, 227
- DSDV, *see* Destination-sequenced distance vector
- DSP, *see* Digital signal processor
- DSR, *see* Dynamic source routing
- DSSS, *see* Direct sequence spread spectrum, 28–31, 98–99, 109
- DSWare, 77
- Duplicate address detection, 184, 189
- Duty cycle, 40, 57, 87, 120–121, 126, 424
- DV-distance, 246
- DV-hop, 246, 322
- DVS, *see* Dynamic voltage scaling
- Dynamic code scaling, 43
- Dynamic hierarchies, 67
- Dynamic host configuration protocol, 185
- Dynamic modulation-code scaling, 43
- Dynamic modulation scaling, 43, 108
- Dynamic power management, 37, 48
- Dynamic source routing, 291, 424
- Dynamic synchronization, 126
- Dynamic voltage scaling, 38–39, 42–45, 49
- Edge effect, 258
- EEPROM, *see* Electrically erasable programmable read-only memory
- EHF, *see* Extremely high frequency
- Electrically erasable programmable read-only memory, 21
- Elephant, 63, 71–72, 122, 426
- Embedded systems, 2, 19
- Emergent algorithm, 281
- Enclosures, 261
- Encoder, 162, 417–420
- Energy
 - consumption, 9, 19–20, 36–44, 49, 61, 65, 85, 103–107, 112, 119–120, 150, 155, 161, 173, 201, 236, 295, 303–305, 349, 354, 389, 399, 415–416
 - cost, 41, 298, 303, 309, 340, 351–352, 385
 - efficiency, 2–3, 9, 13, 22, 37, 44–45, 61, 65, 69, 81, 109–111, 119, 158, 161–163, 168, 173, 262, 274, 280, 285–287, 291, 295–296, 300–303, 310, 313, 340, 345, 352
 - scavenging, 13, 32–36, 291, 294
 - supply, 7, 34, 285, 296
- Entropy, 187–191, 350, 417
- EnviroTrack, 78
- Equalization, 102, 152
- Error control, 96, 112, 149–151, 163, 167, 173
 - ARQ, 48, 103, 151–154, 163
 - bit errors, 90, 95, 152
 - bit-error rate, 23, 88, 95, 101–105, 155, 161, 381
 - concealment, 166
 - FEC, 41, 103, 158–163, 167, 173–174, 377
 - hybrid FEC/ARQ schemes, 163, 167
 - packet loss, 152, 175–177, 360, 376
 - redundancy, 103, 149, 158, 384
- Error recovery, 377, 389
- ESRT, *see* Event-to-sink reliable transport
 - Decision period, 404
- Estimation theory, 350, 421
- Ethernet, 24, 182–185
- Event, 114
 - asynchronous notification, 76
 - complex, 76–77

- handler, 46–47, 50
- predicate, 429–430
- Event-to-sink reliability, 403
- Event-to-sink reliable transport, 402–406
- Exposed-terminal problem, 113, 117
 - busy-tone solution, 116, 131
 - RTS/CTS handshake, 117–119, 124, 131, 146–147, 395
- Exposure, 261, 365
- Expressiveness, 72, 197
- Extremely high frequency, 86

- Failover, 303
- Failure rate, 346, 426
- Fast fading, 92, 151, 157, 170, 235
- Fast Fourier transform, 69, 414–415
- Fault tolerance, 8, 12, 205, 211, 227, 273, 364
- FDMA, *see* Frequency division multiple access, 22, 115, 128, 139
- FEC, *see* Forward error correction, 41, 103, 158–163, 167, 173–174, 377
 - BCH codes, 159–161
 - block coding, 159–161
 - code rate, 41, 159–161, 166
 - constraint length, 42, 160–161
 - convolutional coding, 160–161, 167
 - hamming bound, 159
 - hamming distance, 159
 - hybrid schemes, 163, 167
 - interleaver, 162
 - interleaving, 103, 162–163
 - multihop FEC, 163
 - Reed-Solomon codes, 159–160
- Feedback, 152–154, 158, 166, 403, 407
- FFD, *see* Full function device
- FFT, *see* Fast Fourier transform
- FHSS, *see* Frequency hopping spread spectrum, 99–100, 145
- Fidelity, 49, 70, 81, 286, 419
- Field-programmable gate array, 20, 31, 398
- Field sampling, 432
- Fieldbus, 3, 12–13
- FIFO, *see* First in first out
- Figure of merit, 3, 8, 66, 299, 303, 354
- Filter, 22, 25, 72, 197, 333–334, 343, 349
- Final acknowledgment, 172
- First in first out, 50
- Fixed assignment protocols, 114
- Flat fading, 92, 109
- Flat networks, 253, 256

- Flooding, 72, 194, 245, 282–284, 290–291, 307, 334–340, 355, 388–389
 - controlled, 290
 - restricted, 318, 323
- Flow control, 112, 150, 304, 360–361, 377
- Forward error correction, 41–42, 48, 303
- Forwarding, 289–294, 298, 301–307, 313–336, 340–341, 385, 421–425
 - content-based, 333–334
 - cooperative, 316
 - receiver-initiated, 320
 - zone, 323–324, 329
- FPGA, *see* Field-programmable gate array
- Fragmentation and reassembly, 170–172
- Frame, 22, 50, 100–101, 152, 424
- Frame synchronization, 101, 152
- Framing, 29, 101, 150–152, 167–169, 174
 - frame header, 172–174
 - packet size, 169–173
 - start frame delimiter, 101–102, 152
- Frequency allocation, 86–87
- Frequency band, 24–25, 86–87, 94, 114
- Frequency division multiple access, 22, 115, 128, 139
- Frequency hopping spread spectrum, 99–100, 145
- Frequency shift keying, 22, 30–31, 90, 105–106
- Frequency synchronization, 100–101, 114, 117, 122
- Friis free-space equation, 93
- Frisbee model, 63
- FSK, *see* Frequency shift keying, 22, 30–31, 90, 105–106
- Full function device, 140

- Gabriel graph, 260, 319, 326
- GAF, *see* Geographic adaptive fidelity
- Game theory, 355
- GAMER, *see* Geocast Adaptive mesh environment for routing
- Gateway, 60, 78–81, 275–276, 283–284, 378, 398
 - Distributed, 276
- GEAR, *see* Geographic and energy aware routing
- GEM, *see* Graph embedding
- General sensing model, 363, 368, 426
- Geocast adaptive mesh environment for routing, 325

- Geographic adaptive fidelity, 286–287, 321
 Geographic and energy aware routing, 327, 339
 Geographic hash table, 356–357
 GeRaF, 320–321
 GHT, *see* Geographic hash table
 Gilbert–Elliot model, 97
 Global positioning system, 203–207, 231, 248, 428
 GOAFR, *see* Greedy and (other adaptive) face routing
 Goback N, 154–158
 GPS, *see* Global positioning system
 GPSR, *see* Greedy perimeter stateless routing
 GRAB, *see* Gradient broadcast
 Gradient, 337–338, 341, 352
 Cache, 337
 Gradient broadcast, 340
 Graph embedding, 321–322, 357
 Greedy and (other adaptive) face routing, 320
 Greedy perimeter stateless routing, 318–320, 352, 356
 Group dispersion, 220–221
 Growth budgets, 282
 GTS, *see* Guaranteed time slot
 Guaranteed delivery, 378, 395
 Gur game, 406, 411
- Hölder- α regular, 434
 Haar estimator, 434
 Half-duplex mode, 114
 Hamming bound, 159
 Hamming distance, 159, 418–419
 Handoff, 427
 Hardware clock, 203
 oscillator, 25, 100, 203–204
 Header checksum, 152, 172
 HELLO, 190, 193
 Heterogeneity, 57, 274, 283, 422
 HHB, *see* Hop-by-hop broadcast
 HHBA, *see* Hop-by-hop broadcast with acknowledgments
 HHR, *see* Hop-by-hop reliability
 HHRA, *see* Hop-by-hop reliability with acknowledgments
 Hidden Markov model, 97
 Hidden-terminal problem, 113, 116, 119, 124, 129, 133
 busy-tone solution, 116, 131
 RTS/CTS handshake, 117–119, 124, 131, 146–147, 395
- Hierarchical networks, 253, 266, 274
 Hierarchy, 67, 266, 274–276, 283, 347–348, 354
 Hierarchy referencing time synchronization, 223–228
 HMM, *see* Hidden Markov model
 Homing, 425
 Hop-by-hop broadcast, 385–388
 Hop-by-hop broadcast with acknowledgments, 385, 388
 Hop-by-hop reliability, 383–388
 Hop-by-hop reliability with acknowledgments, 383–385, 388
 Hotspots, 357
 HRTS, 223–228
 ITR, 224, 228
 TSync protocol, 223
 Humidity, ventilation, air conditioning, 4
 HVAC, *see* Humidity, ventilation, air conditioning
- I2C, *see* Inter integrated circuit bus
 Identifier, 264, 278–279, 282, 314, 326, 348
 resource, 182
 unique, 11, 24, 184, 240, 266, 271–272, 277, 338
 unique node, 182, 190, 289
 Idle listening, 111, 120–123, 131–133
 IDSQ, *see* Information-driven sensor querying,
 see Information-driven sensor query
 IEEE, *see* Institute of Electrical and Electronics Engineers
 IEEE 802.11, 26, 41–42, 79, 87, 90, 99, 113, 117–119, 145, 265, 297
 DCF, 116, 146
 Point coordination function, 146
 IEEE 802.15.4, 24, 28–30, 87, 100, 126, 139, 220
 backoff periods, 143–145
 beaconed mode, 140–141, 220
 contention access period (CAP), 141–143
 coordinator, 140–145
 full function device, 140
 guaranteed Time Slots (GTS), 141–142
 nonbeaconed mode, 144
 PAN coordinator, 140
 PAN identifier, 140
 reduced function device, 140
 ZigBee, 140
 IEEE 802.3, 183–185

- IF, *see* Intermediate frequency
- IFS, *see* Inter frame space
- Implicit acknowledgment, 379
- Implosion, 334–335
- Incomplete acknowledgment, 172
- Independent set, 253, 275, 278–279
- Industrial, scientific, and medical band, 25, 87, 114
- Information accuracy, 360–361, 402, 409
- Information-driven sensor querying, 351, 428
- Information theory, 109, 132, 421, 435
- Information utility measures, 350
- In-network processing, 9–10, 44, 67–68, 71, 76–77, 81, 125, 194, 334–335, 341, 357, 398, 403, 413–415, 420, 423
- Instantaneous feedback with selective repeat, 157
- Intentional naming system, 198
- Inter integrated circuit bus, 54
- Inter symbol interference, 92, 97
- Interaction patterns, 6, 60, 73
- Interest, 70–72, 194–197, 284, 332, 337–340, 353, 424, 428
 - cache, 195–196
 - flood, 337
- Interface, 10, 20–22, 47, 51–53, 70, 73–77, 81, 181–182, 335, 339–342, 352, 361
- Interference, 23, 27, 42, 87–88, 92–95, 116, 151, 241, 252, 265, 272, 297, 424
 - Adjacent-channel, 94
 - Co-channel, 94
- Interleaving, 103, 162–163
- Intermediate checksums, 165, 172–174
 - final acknowledgment, 172
 - incomplete acknowledgment, 172
- Intermediate frequency, 25
- IP, 53, 71, 79–80, 181–183, 188, 194, 198, 377, 398
- ISI, *see* Inter symbol interference
- ISM, *see* Industrial, scientific and medical
- Iterative multilateration, 245
- ITR, 224, 228

- Jamming, 423–424

- Key management, 423–425
- Key value, 423

- LAR, *see* Location-aided routing
- Latency, 7, 43, 69, 123–125, 209, 307, 321, 342, 345

- Lateral inhibition, 428
- Lateration, 234, 237
- LBM, *see* Location-based multicast
- LEACH, *see* Low-energy adaptive clustering hierarchy
 - advertisement phase, 134
 - member nodes, 133–134
 - setup phase, 134
- LED, *see* Light emitting diode
- Lifetime, 8–10, 33, 36, 65, 248, 263, 285, 296–300, 305, 315, 327–329, 342, 347
- Light emitting diode, 28
- Lightweight time synchronization protocol, 207, 210–211, 214, 228
- Line of sight, 91–92, 96–98
- Link
 - quality, 174–175, 305
- Link layer, 74, 149–151, 305
 - asymmetric links, 175, 189, 256, 264–265
 - channel estimation, 150, 170, 177
 - framing, 29, 101, 150–152, 167–169, 174
 - management, 150, 174
 - services, 150
 - duplicate-free, 151
 - error-free, 151
 - in-sequence, 151
 - loss-free, 151
- Listen period, 121–123, 126, 129
- LMST, *see* Local minimum spanning tree
- LNA, *see* Low noise amplifier
- Load, 279–282, 285, 291, 303, 327, 353
- Local interaction, 337, 345
- Locality, 10
- Localization, 74, 231–233, 236, 240, 326, 414, 426
 - error, 326
- Location, 3, 10, 65, 73, 76, 194, 198, 231–233, 237, 240–241, 247–248, 274, 287, 293, 299, 305, 310, 320–323, 327–329, 341, 356, 425–428
 - service, 316, 326
- Location-aided routing, 327
- Location-based addresses, 71
- Location-based multicast, 323–324, 327
- Log-distance model, 93–94
- Logical time, 202–204
- Lognormal fading, 93
- LOS, *see* Line of sight
- Loss propagation, 391
- Low-energy adaptive clustering hierarchy, 133–135, 279–280, 304, 354–355, 407

- Low noise amplifier, 25, 42
- LTS, 207, 210–211, 214, 228
 distributed multihop LTS, 211–212
 path diversification, 211–212
- MAC, *see* Medium access control
 preamble sampling, 129, 399
- MAC layer protocol data unit, 151–152
- MACA, 113, 117, 131
- MACAW, 113, 117
- Magic numbers, 257
- Maintainability, 8–9
- Maintenance, 2, 5–9, 13, 190, 274, 289, 328
- Manager node, 427–428
- MANET, *see* Mobile ad hoc network
- Maximal support path, 365
- Maximum breach path, 364, 372
- Maximum independent set, 275–281, 284
- Maximum likelihood estimation, 171
- Maximum weight independent set, 278
- MBCR, *see* Minimum battery cost routing
- MCDS, *see* Minimum connected dominating set
- MDS, *see* Minimum dominating set, *see* Multidimensional scaling
- Mean square error, 239–240
- Mean squared error, 433–435
- Measurement, 31–32, 42, 72, 97, 176, 236–238, 247, 346–348, 351, 354, 415, 422, 429, 432–433
- Mediation device, 126
- Mediation device protocol, 126, 156
 distributed mediation device protocol, 127
 dynamic synchronization, 126
 mediation device, 126
 query beacon, 126–127
- Medium access control, 22–24, 27, 111–114, 119–120, 182, 186, 274, 281, 292, 307, 336, 424
 address, 122, 128, 182–191, 198
 ALOHA, 22, 116, 119, 129, 133, 257
 backoff algorithm, 116, 131
 binary exponential backoff, 116, 131
 CDMA, 99, 115, 128, 135, 265, 354
 contention-based, 115, 120, 129, 139, 182, 185, 198
 CSMA, 22, 113, 116, 119, 124, 128–131, 134, 138, 142, 145–147, 394, 399
 collision avoidance, 119, 143
 collision detection, 113–114
 nonpersistent CSMA, 116–117, 130, 146
 persistent CSMA, 116
 cycled receiver, 121, 129
 demand assignment protocols, 115, 119
 FDMA, 22, 115, 128, 139
 fixed assignment protocols, 114
 idle listening, 111, 120–123, 131–133
 IEEE 802.11, 26, 41–42, 79, 87, 90, 99, 113, 117–119, 145, 265, 297
 IEEE 802.15.4, 24, 28–30, 87, 100, 126, 139, 220
 IEEE 802.3, 183–185
 LEACH, 133–135, 407
 mediation device protocol, 126, 156
 periodic wakeup, 121–123, 126–128
 power-controlled MAC, 146
 priority, 112
 protocol overhead, 120
 random access protocols, 114–115
 schedule-based, 112, 120, 133, 140, 198
 SDMA, 115
 slotted ALOHA, 116
 TDMA, 114–115, 119–120, 133–136, 139, 146–147, 202
 TRAMA, 137–139, 147, 175
- MEMS, *see* Microelectromechanical system
- Message overhead, 342
- Metadata, 197
- Metric, 3, 8, 33, 39, 44, 50, 65–66, 70, 150, 157–159, 170, 205, 232, 254–255, 265–266, 273, 278, 290, 295–302, 321–322, 342, 351, 354
- Microcontroller, 19–22, 36–38, 44
- Microelectromechanical system, 34
- Middleware, 81, 198
- Min–Max battery cost routing, 297
- Miniaturization, 13, 35
- Minimum battery cost routing, 296
- Minimum connected dominating set, 266
- Minimum dominating set, 266
- Minimum total transmission power routing, 297
- MiniSync, 226–227
- MIP, *see* Multicast incremental power
- Misdirection, 424
- Mission time, 7–8
- MLE, *see* Maximum likelihood estimation
- MMBCR, *see* Min–Max battery cost routing
- Mobile ad hoc network, 10–12, 188–189
- Mobile agents, 59, 70, 77, 248, 295, 415–416
- Mobile code, 69–70, 77, 336
- Mobile ubiquitous LAN extension, 328

- Mobility, 10–12, 62–63, 103, 175, 235, 254, 265, 278–280, 285, 318, 325–328
 event mobility, 63
 node mobility, 62, 279, 325
 sink, 62
- Modulation, 22–23, 30, 40–44, 48, 85, 88–89, 95, 102–104, 107, 424
 m -ary, 88, 104–105
 ASK, 22, 29–30, 89
 bandpass modulation, 88
 bandwidth efficiency, 40, 95, 105–106
 binary, 88, 106
 BPSK, 30, 89–90, 95, 98
 demodulation, 22, 85, 88, 100
 dynamic scaling, 108
 FSK, 22, 30–31, 90, 105–106
 OOK, 43, 89, 101
 PPM, 27
 PSK, 89, 95, 105
 QAM, 90, 107
 QPSK, 30, 89–90, 98
 spread-spectrum, 27, 88, 98, 424
 symbol error rate, 88, 93, 102
 symbol rate, 22, 30, 88, 104
 ultrawideband, 87
- Module, 51
- Monitor state, 122
- Monotone property, 256–257
- MPDU, *see* MAC layer protocol data unit
- MPEG, 415
- MSE, *see* Mean squared error
- MSP 430, 20, 38
- MST, *see* Minimum spanning tree
- MTPR, *see* Minimum total transmission power routing
- MTSP, 228
- MULE, *see* Mobile ubiquitous LAN extension
- Multicast, 112, 291, 305–316, 328, 333–334, 339, 378, 393, 400, 420–421
 core, 307, 314, 325
 core-based tree, 307, 314
 mesh-based protocol, 307, 314–315, 325
 source-based tree, 306–308, 314
- Multicast incremental power, 312, 315
- Multidimensional scaling, 244
- Multihop, 9–10, 41, 60–61, 68, 97, 121, 166, 204–206, 243–245, 254, 258, 283, 289, 295, 310, 361, 376
- Multihop time synchronization protocol, 228
- Multilateration, 234, 240, 244–246
- Multipath fading, 92, 98
- MWIS, *see* Maximum weight independent set
- Myopic, 268
- Named data, 72, 194, 197, 333–337
- Naming, 72, 181–186, 194–198, 333
 attribute-based, 194, 333
 name resolution, 183
- NAT, *see* Network address translation
- NAV, *see* Network allocation vector, 117–118, 124–125, 146–147
- Neglect and greed, 424
- Neighborhood discovery, 135–137, 175, 190
- Neighborhood table, 175
- nesC, 50–52
- Network abstraction, 361
- Network address translation, 79
- Network allocation vector, 117–118, 124–125, 146–147
- Network coding, 414, 420–422
- Network partition, 66, 183, 189, 296
- Network time protocol (NTP), 206–207, 221, 228
- Networking
 address-centric, 9–10
 agent-based, 69–70, 76, 292–294
 content-based, 331–333
- NLOS, *see* Non line of sight
- Node capture, 423
- Node-centric, 292
- Node coverage, 364–368, 374–375
- Node density, 8–10, 132, 191–193, 199
 density inference protocol, 375
 estimation, 375
- Noise, 23, 40, 88–90, 94–98, 115
- Non line of sight, 91, 152
- Nonbeaconed mode, 144
- Nonpersistent CSMA, 116–117, 130, 146
- Normal equation, 239
- NP-complete, 257, 270, 273–275, 282, 285, 296, 306–309, 421
- NP-hard, 256–258, 266, 278, 307, 315, 376
- Number of neighbors, 132, 191, 251–254, 257–259, 264–266, 293, 431
- Objective function, 256, 352
- On demand, 184, 206, 228
- On-off keying, 43, 89, 101
- OOK, *see* On off keying, 43, 89, 101
- Operating system, 13, 45–54, 74–75
- Operation time, 3

- Operator, 72, 195
- Optical, 21, 28, 86
- Optimal stopping rules, 346
- Optimization, 48, 63–65, 74–75, 102, 173, 246, 254, 257, 276, 286, 293, 296–299, 304–307, 314, 335–337, 347, 421
 decision variables, 286, 347
 integer program, 347
 linear program, 273, 298, 315, 347, 376
- Oscillator, 25, 30, 34, 100, 203–204
- Overhead, 37–38, 41–42, 100, 111–112, 118–120, 145, 159, 167, 185–186, 235–236, 254, 279, 291–292, 297, 303, 307, 334, 338–340, 379, 415
- Overhearing, 111, 119, 123–124, 131–132, 182, 185–186, 198
- Overlay networks, 71
- PA, *see* Power amplifier
- Packet
 combining, 165
 dropping, 403
 formatting, 153
 loss, 152, 175–177, 360, 376
 size optimization, 169–173
- PAMAS, 131–132, 147
 Probing protocol, 132
- PAN, *see* Personal area network
- PAN coordinator, 140
- PAN identifier, 140
- Pareto optimality, 304
- Partial state record, 343–344, 352
- Path loss, 40, 61, 93–94, 97–98, 113, 235, 263, 286
- Path-loss exponent, 93–94
- PCF, *see* Point coordination function
- PDA, *see* Personal digital assistant
- Peer-to-peer, 59, 71, 126, 133, 140, 198, 355
- PEGASIS, *see* Power-efficient gathering in sensor information systems
- PER, *see* Packet error rate
- Percolation theory, 256, 265
- Perimeter-covered, 370
- Periodic wakeup, 121–123, 126–128
- Persistent CSMA, 116
p-persistent CSMA, 116
- Personal digital assistant, 4–6, 60–62, 78
- Pervasive control, 3
- Phase shift, 203–204, 221
- Phase shift keying, 89, 95, 105
- Phase transition, 255–256, 292, 320
- PHY, *see* Physical layer
- Physical layer, 103
- Physical layer protocol data unit, 151
- Physical time, 202–204
- Piggyback ack, 154–156
- Placement, 244, 247–248, 316, 345, 362, 424, 430
- Planar graph, 319, 326
- Platelets, 433–434
- Point coordination function, 146
- Point in triangle, 242
- Point sensors, 363, 432–433
- Point-in-polygon test, 198
- Poisson point process, 365–368
- Poisson shot noise, 368
- Polynomial time approximation scheme, 266, 275
- Positioning, 231–233, 236–237, 240–244, 247–248, 414
 error, 241–243, 248
- Post-facto synchronization, 205–206, 212, 217, 221, 228
- Power
 amplifier, 23
 efficiency, 41
 control, 22, 109, 146, 165, 252–256, 265, 285, 305, 354
 level, 40, 166, 264–265, 286, 298, 310
 management, 26, 48–49
 supply, 2, 13, 19, 32
- Power amplifier, 25, 41, 107
- Power-efficient gathering in sensor information systems, 354
- Power spectral density, 94
- PPDU, *see* Physical layer protocol data unit
- PPM, *see* Pulse position modulation
- Preamble, 100–102, 129, 151
- Preamble sampling, 129, 399
- Prediction, 171, 178, 415
 prediction-based monitoring, 415
- Price, 3, 233
- Prim's algorithm, 260, 308–311
- Priority, 112
- Probabilist density, 348
- Probability density, 213, 235, 247, 417
- Probing radius, 430
- Programmability, 8, 20
- Proximity, 233, 323, 348, 414–416
- Proximity graphs, 259
- PSD, *see* Power spectral density

- PSFQ, *see* Pump slowly fetch quickly, 389–395
 - fetch operation, 390–393
 - loss propagation, 391
 - NACK, 390–393
 - proactive fetch, 392–393
 - pump operation, 389–391
 - report operation, 393
- PSK, *see* Phase shift keying, 89, 95, 105
- PTAS, *see* Polynomial time approximation scheme
- Publish/subscribe, 48, 72, 331–334, 337–339
 - topic-based, 332
- Pulse position modulation, 27
- Pump slowly fetch quickly, 389–395

- QAM, *see* Quadrature amplitude modulation, 90, 107
- QoS, *see* Quality of service
- QPSK, *see* Quaternary phase shift keying, 30, 89–90, 98
- Quadrature amplitude modulation, 90, 107
- Quadtree, 431–432, 435
- Quality of information, 8
- Quality of service, 7–9, 12, 64–67, 70, 359–362
- Quaternary phase shift keying, 30, 89–90, 98
- Query, 73, 265, 315, 336, 342, 350–355
 - manager, 77
 - nested, 197
 - one-shot, 305, 335–337

- RADAR, 31, 240
- Radiated power, 23, 29–31, 40–41, 87, 93, 102–105
- Radio frequency, 21, 25, 40
- Radio frequency frontend, 24–25, 42, 103
- Radio frequency identifier, 5, 146
- Radio frontends
 - chipcon CC1000, 29, 54
 - chipcon CC2420, 29–30
 - Ember EM2420, 30
 - infineon TDA 525x, 30
 - RFM TR1000, 29, 42, 101
- Radio modems, 13, 37, 45
- RAM, *see* Random access memory
- Random access memory, 21
- Random access protocols, 114–115
- Random deployment, 7, 270, 365–366
- Random walk, 290, 293

- Range, 23, 103
- Ranging, 234–236, 240, 243, 248
- Rate control, 361, 400, 403
 - Gur game, 406, 411
- Rayleigh fading, 96–97, 103, 107, 160, 169, 173
- RBS, 216–223, 226–228
 - gateway nodes, 223
 - group dispersion, 220–221
 - pulse packet, 218
 - timestamp conversion, 221–222
- Read-only memory, 21
- Real-time, 8, 11–13, 59
- Received signal strength indicator, 23–24, 30, 170, 235–236, 249, 265
- Receiver sensitivity, 23
- Reconstruction, 433
- Recovery server, 389
- Reduced function device, 140
- Reduced instruction set computer, 20
- Redundant, 65–66, 238, 262, 302, 307, 334–336, 415
- Reed-Solomon codes, 159–160
- Reference broadcast synchronization, 216–223, 226–228
- Reflection, 28, 90, 151
- Reinforcement, 302, 338–339, 345
- ReInForM, 384
- Relative neighborhood graph, 259–260, 313, 319
- Relaxation, 33, 273, 315, 327, 347
- Relay regions, 261, 298
- Reliability, 149, 155, 161, 165–167, 315, 345, 348, 360, 378, 397
 - information accuracy, 360–361, 402, 409
 - reliable data transport, 361, 376–377
 - requirements, 8, 155, 162, 166, 377–378
- Reliability requirement, 8
- Reliable data transport, 361, 376–377
 - block delivery, 377–378, 389, 395
 - error recovery, 377, 389
 - ESRT, 402–406
 - event-to-sink, 403
 - guaranteed delivery, 378, 395
 - PSFQ, 389–395
 - ReInForM, 384
 - RMST, 395–396
 - single packet delivery, 377–379
 - stochastic delivery, 378
 - stream delivery, 377–379
- Reliable multisegment transport, 395–396

- Remote clock estimation block, 206
 - remote clock reading, 206–208
 - time transmission technique, 206
- Reprogramming, 53
- Request to send, 117–120, 125, 146, 396, 424
- Residual error rate, 153, 160–162
- Resiliency, 291, 303, 384, 423
- Resolution, 5–6, 236, 241, 274, 416, 431
- Retransmission, 103, 149, 152–154, 157, 165, 172, 305–307, 379, 424–425
 - postponing, 157
- RF, *see* Radio frequency
- RFD, *see* Reduced function device
- RFID, *see* Radio frequency identifier
- Rice fading, 96
- RISC, *see* Reduced instruction set computer
- RMST, *see* Reliable multisegment transport, 395–396
 - back channel, 395–396
 - cached mode, 395–397
 - NACK, 395
 - noncached mode, 396
- RNG, *see* Relative neighborhood graph
- Robust header compression, 398
- Robustness, 67, 254, 301–304, 314–315, 340, 377
- ROHC, *see* Robust header compression
- ROM, *see* Read-only memory
- Routing
 - ad hoc, 265, 287, 291, 301, 325–327, 340
 - face, 318–320, 326
 - geocasting, 316, 323–327, 339–340, 353
 - geographic, 198, 291–292, 316–317, 321, 326–327, 339, 356
 - dead end, 317–319, 325, 352
 - GPSR, 318–320, 352, 356
 - mobicast, 329
 - perimeter, 318, 356
 - gossiping, 290–292, 295, 307, 315, 336, 347–350
 - information-driven, 350–352
 - multicast
 - location-based, 323
 - multiple paths, 291, 301–304, 340, 379, 384
 - braided, 302–304, 384
 - disjoint, 302, 303, 384, 425
 - position-based, 316, 320
 - rumor, 292–294, 350
 - table, 66, 264, 286, 290–291
 - unicast, 291–297, 301, 325, 356
- RS, *see* Reed-Solomon
- RSSI, *see* Received signal strength indicator
- RTS, *see* Request to send
- RTS/CTS, 265, 424
- RTS/CTS handshake, 117–119, 124, 131, 146–147, 395
 - NAV, 117–118, 124–125, 146–147
- Run to completion, 47, 50–51
- Runtime environment, 13
- S-MAC, 121–126, 138, 147, 175, 424
 - adaptive listening, 124
 - CTS phase, 124
 - RTS phase, 124
 - SYNCH phase, 124
 - virtual clusters, 124
- SAR, *see* Sequential assignment routing
- Scalability, 8, 66, 114, 119, 206, 314, 337, 347
- Scalable reliable multicast, 378, 393–395
- Scalar field, 429, 432–435
- Scattering, 90–91, 94, 151
- Scene analysis, 233, 237, 240
- Scheduling, 26, 38, 138, 166, 280, 305, 340, 352, 376, 399
- Scoping, 7, 10, 339, 355
- SDMA, *see* Space division multiple access, 115
- Security, 355, 422–425
 - exhaustion attack, 423
- Selective reject, 153–156
- Selective repeat, 154–158
- Self configurability, 10
- Self-discharge, 13, 33
- Self-organization, 67
- Self-organizing medium access control for sensor networks, 135–136, 147, 185
- Sensing models, 362–363
 - Boolean sensing model, 363, 366–369, 374–375
 - directionality, 362
 - general sensing model, 363, 368, 426
 - point sensors, 363, 432–433
 - sensing radius, 366, 370
- Sensing radius, 366, 370
- Sensing range, 32, 363–364
- Sensor, 31, 44
 - fusion, 414
 - rich, 6
 - starved, 6

- Sensor field intensity, 364–365, 368–369
- Sensor protocol for information via negotiation, 197, 335–336
- SensorML, 78
- SensorWare, 77
- Sequence number, 153–154, 174, 178, 290, 390, 425
- Sequential assignment routing, 301
- Serial peripheral interconnect, 54
- SFD, *see* Start frame delimiter, 101–102, 152
- Shortest path tree, 308
- Signal stability routing, 291
- Signal to interference and Noise Ratio, 23, 95, 297
- Signal to noise ratio, 23, 61, 88, 95–96
- Single packet delivery, 377–379
- Sink, 6, 279–280, 284, 301–302, 305, 328, 332, 341, 353–354
- SINR, *see* Signal to interference and noise ratio
- Sleep
 - mode, 26, 37–38, 49, 104, 111, 121, 124–126, 182, 186, 362, 427
 - state, 19, 26, 37, 48–49, 63, 104, 112
- Slepian–Wolf theorem, 69, 414, 417–420
- Slotted ALOHA, 116
- Slow fading, 94, 151, 157, 170
- SMACS, *see* Self-organizing medium access control for sensor networks
 - receive slot, 136
 - transmit slot, 136
- Smoothness, 433
- SNR, *see* Signal to noise ratio
- Software bus, 332–333
- Software clock, 203
 - clock adjustment, 203, 227
 - clock skew, 204
 - drift rate, 203–205, 210, 221, 227
 - phase shift, 203–204, 221
- Source, 6, 71, 302, 310, 332, 389–390
- Source coding, 69, 414–419, 433
- Space division multiple access, 115
- Span, 272
- Spanner graphs, 257
- Spanning tree, 207, 210, 260, 267–268, 282–283, 309–310, 322
 - local minimum spanning trees, 260
 - minimum cost spanning tree, 306–308, 312
 - minimum spanning tree, 263, 270, 312–313
- Sparse networks, 258, 328
- Sparse topology and energy management, 121–123, 128, 147, 287
- Spatial cells, 427
- SPI, *see* Serial peripheral interconnect
- SPIN, *see* Sensor protocol for information via negotiation
- Split-phase programming, 51
- Spread-spectrum, 27, 88, 98, 424
- Spread-spectrum systems, 98
 - chip sequence, 31, 98
 - DSSS, 28–31, 98–99, 109
 - FHSS, 99–100, 145
 - spreading factor, 31, 98
- Spreading factor, 31, 98
- SPT, *see* Shortest path tree
- SQL, *see* Standard query language
- SRM, *see* Scalable reliable multicast
- SSR, *see* Signal stability routing
- Standard query language, 73, 342–343, 352
- Start frame delimiter, 101–102, 152
- Startup energy, 26, 104–105, 129
- Steiner tree, 269–270, 276–279, 306–310, 316, 328, 341, 345, 421
- STEM, *see* Sparse topology and energy management, 121–123, 128, 147, 287
 - monitor state, 122
 - STEM-B, 122–123
 - STEM-T, 122–123
 - transfer state, 122
- Stochastic delivery, 378
 - delivery probability, 155, 378–379, 385, 389
- Storage, 21, 323, 332, 356
 - location, 356
- Store and forward, 61
- Stream delivery, 377–379
- Stretch factors, 254
- StrongARM, 20, 38
- Superframe, 114, 135–137, 141–142
- Swarm intelligence, 59, 70
- Symbol error rate, 88, 93, 102
- Symbol rate, 22, 30, 88, 104
- Synchronization
 - bit/symbol, 101
 - carrier, 100–101
 - frame, 101, 152
- Synchronization mesh, 206
- Syndrome, 419
- T-MAC, 126
- TAG, *see* Tiny aggregation
- TBF, *see* Trajectory-based forwarding

- TCP, *see* Transmission control protocol
- TDMA, *see* Time division multiple access, 114–115, 119–120, 133–136, 139, 146–147, 202
- Time slots, 114–115, 120, 124, 133, 185, 340
- TDoA, *see* Time difference of arrival
- Temporally ordered routing algorithm, 291, 301, 325, 340
- Throughput, 44, 112, 254, 257, 264–265
- Time difference of arrival, 236
- Time division multiple access, 114–115, 119–120, 133–136, 139, 146–147, 202
- Time of arrival, 236, 240, 243
- Time resolution, 203
- Time slots, 114–115, 120, 124, 133, 185, 340
- Time synchronization, 114, 201–203
- clock correction block, 206
 - clock-update discipline, 205–207
 - external, 203
 - hardware clock, 203
 - HRTS, 223–228
 - internal, 203–204
 - logical time, 202–204
 - LTS, 207, 210–211, 214, 228
 - MTSP, 228
 - physical time, 202–204
 - post-facto synchronization, 205–206, 212, 217, 221, 228
 - RBS, 216–223, 226–228
 - receiver uncertainty, 216–220
 - remote clock estimation block, 206
 - resynchronization event detection, 205
 - software clock, 203
 - synchronization mesh setup, 206
 - time resolution, 203
 - TPSN, 214–219, 225, 228
 - transmitter uncertainty, 216, 220
 - UTC, 202–204, 207, 216
- Time to live, 390, 393
- Timer, 153–154, 382
- Timestamp conversion, 221–222
- Timing-sync protocol for sensor networks, 214–219, 225, 228
- Tiny aggregation, 342, 352–353
- TinyOS, 48–52, 74
- TinySync, 226–227
- ToA, *see* Time of arrival
- Token frame, 115
- Token-passing protocols, 115
- Tolerance radius, 429
- Topology control, 251–256, 260–265, 272, 286–287, 290–292, 298, 304, 315, 340
- cone-based, 262
- TORA, *see* Temporally ordered routing algorithm
- TPSN, 214–219, 225, 228
- Tradeoff, 8–10, 13, 17–20, 32–34, 43, 47–50, 57, 62, 65, 69, 75–79, 185–186, 198, 236, 248, 252, 317, 324, 343, 426, 430, 435
- Traffic-adaptive medium access, 137–139, 147, 175
- Trajectory-based forwarding, 326
- TRAMA, *see* Traffic-adaptive medium access, 137–139, 147, 175
- adaptive election algorithm, 138
 - neighborhood protocol, 138
 - random access periods, 137
 - schedule exchange protocol, 138
 - scheduled-access periods, 137
- Transceiver, 21–26, 29, 40, 43–44, 85, 100, 103–104, 114
- Transfer state, 122
- Transmission control protocol, 48, 53, 361, 377–378, 397–399, 425
- Transmission delay, 112, 119
- Transmitter uncertainty, 216, 220
- Transport protocols, 359–361, 377–378
- Triangulation, 233–234, 238, 245
- Trilateration, 233–234
- TSync protocol, 223
- TTDD, *see* Two-tier data dissemination
- TTL, *see* Time to live
- Tunneling, 81
- Two-tier data dissemination, 314, 339–341
- Type of service, 7, 64
- Ubiquitous computing, 2
- Ultrasound, 21, 28–29, 236, 240
- Ultrawideband, 27–28, 87
- UML, *see* Unified modeling language
- Uncertainty, 209, 212–216, 324, 348–352, 428
- Unguided medium, 86
- Unified modeling language, 78
- Unique identifier, 11, 24, 182–184, 190, 240, 266, 271–272, 277, 289, 338
- Unit disk graph, 255
- Universal transverse mercator, 232
- UTC, 202–204, 207, 216

- UTM, *see* Universal transverse mercator
- UWB, *see* Ultrawideband

- VCO, *see* Voltage-controlled oscillator
- Very low frequency, 86
- VHF omnidirectional ranging, 248
- Virtual polar coordinate routing, 323
- Virtual polar coordinate space, 322
- VLF, *see* Very low frequency
- Voltage controlled oscillator, 31
- VOR, *see* VHF omnidirectional ranging
- Voronoi diagram, 260, 324–325, 371–372
- VPCR, *see* Virtual polar coordinate routing
- VPCS, *see* Virtual polar coordinate space

- Wakeup radio, 26, 120–121, 127–128, 147
- Wave propagation, 90, 236–237
 - attenuation, 23, 61, 88, 91–94, 108, 151, 235–236, 297
 - AWGN, 94–99, 103–105, 109
 - coherence bandwidth, 92, 97
 - delay spread, 92, 97–98
 - diffraction, 90–91, 151
 - doppler fading, 90–91
 - fast fading, 92, 151, 157, 170
 - flat fading, 92, 109
 - friis equation, 93
 - intersymbol interference, 92, 97
 - log-distance model, 93–94
 - lognormal fading, 93
 - multipath fading, 92, 98
 - noise, 88–90, 94–98, 115
 - path loss, 40, 61, 93–94, 97–98, 113
 - path-loss exponent, 93–94
 - rayleigh fading, 96–97, 103, 107, 160, 169, 173
 - reflection, 28, 90, 151
 - rice fading, 96
 - scattering, 90–91, 94, 151
 - slow fading, 94, 151, 157, 170
- Web service description language, 80–81
- Windowed feedback with selective repeat, 156
- Wireless channel, 102, 233, 284, 377
- Wireless communication, 2, 9–11, 21, 28
- Wireless multicast advantage, 292, 307–314, 336, 421
- Wireless personal area network, 30
- Wireless routing protocol, 291
- Wiring, 2, 48, 51
- WLAN, *see* Wireless local area network
- Worst-case coverage, 364, 371–372
- WPAN, *see* Wireless personal area network
- WRP, *see* Wireless routing protocol
- WSDL, *see* Web service description language
- WSN, *see* Wireless sensor network

- Zebra, 428
- ZigBee, 140