Index

Absorptive shielding, 544
Access network, 490, 500, 514, 533, 563, 564
Active antenna system (AAS), 293
Adaptive quantization, 439
Additive quantization noise model, 437
Additive white Gaussian noise (AWGN), 17, 145, 376, 387, 490
Adjacent channel interference (ACI), 48
Air interface, 93, 118, 170, 370, 501, 506
Amplifier distortion, 419
Analog-to-digital convertor, 236
Analysis filter, 51
Antenna gain, 358
Antenna separation, 543
Augmented reality, 485
Auxiliary chain, 374
Azimuth domain, 369
Back-to-back relay, 409
Backhaul resources, 485, 486, 506
Base station (BS), 117, 145, 157, 198, 377, 409
Baseband processing, 209
Baseband unit (BBU), 433
Beam acquisition, 368
Bi-orthogonal frequency division multiplexing (BFDM), 6
Binary-continuous variable, 519
Bisection search, 518
Bit density, 33, 37, 38
Bit-error ratio (BER), 15
Carrier frequency offset (CFO), 331
Cell-specific reference signals, 368
Central Controller (CC), 216
Channel encoding, 433
Channel estimation, 19, 59, 68, 83, 106, 365
Channel impulse response, 6, 11, 68, 71, 83
Channel matrix, 443
Channel state information, 434
Channel taps, 418
Charnes–Cooper transform, 467
Circular convolution, 11, 171, 185
Circulator, 543
Circulator leakage, 375
Cloud radio access network (C-RAN), 433
Cluster-level evolution, 360
Co-channel interference, 403
Code-division multiple access (CDMA), 115
Cognitive radio (CR), 48
Coherence time, 438
Common public radio interface (CPRI), 293
Common reference signal, 565
Concavity property, 463
Continuous aperture phased MIMO (CAP-MIMO), 236
Cooley–Tuckey FFT algorithm, 341
Cooperative multi-point (CoMP), 369, 503, 565
Covariance matrix, 443
Cross polarization, 380
Cyclic autocorrelation, 554
Cyclic prefix (CP), 5, 369, 549
Delay spread, 365
Demapping, 433
Device-to-device (D2D), 458
Diagonal matrix, 447
Diffuse multipath (DMC), 263
Digital predistortion (DPD), 385
Digital signal processor (DSP), 315
Digital-to-analog convertor (DAC), 236
Dinkelbach’s algorithm, 467
Direct memory access (DMA), 336
Direct path, 375
Directional antennas, 544
Directional isolation, 379
Discrete Fourier transform (DFT), 341
downlink (DL), 330, 337, 505, 533, 534
Dual connectivity, 495
Dual-polarized antenna, 544
Dynamic point blanking (DPB), 489
Dynamic point selection (DPS), 489
Dynamic shadow fading, 360
Dynamic spectrum allocation (DSA), 48
Eigen-beamforming, 281
Eigenfunction, 239
Eigenmode, 415
Eigenvalue, 418
Eigenvector, 279
Enhanced mobile broadband (eMBB), 570
Equalization, 31
Ergodic rate, 437
Error detection, 433
Error vector magnitude (EVM), 206, 216, 306
Euclidean distance, 15
Expectation operator, 435
Fast Fourier transform (FFT), 181, 433, 549
Faster-than-Nyquist (FTN), 15, 30, 33
Field-programmable gate array (FPGA), 551
Filter bank, 49
Filter-bank multicarrier (FBMC), 50, 181, 183
Filtered-OFDM, 14
Finite impulse response (FIR), 181, 183, 419
Finite-rate feedback channel, 481
Fixed-point equations, 474
Forward error correction (FEC), 306, 309, 330, 337, 348
Fractional programming, 458
Frame synchronization, 434
Free-space propagation loss, 355
Frequency division duplexing (FDD), 373
Frequency synchronization, 331
Fronthaul capacity, 440
Fronthaul compression, 445
Full duplex relaying (FDR), 374
Full-dimensional MIMO (FD-MIMO), 263
Full-duplex (FD), 373, 385, 386, 471, 534, 540
Full-duplex transceiver, 417
Game theory, 458
Gaussian matrix, 437
Gaussian minimum shift keying (GMSK), 4
Gaussian noise, 376
Gaussian quantization noise, 437
Generalized concavity, 466
Generalized frequency division multiplexing (GFDM), 6, 171, 183
Geometric tools, 458
Geometry-induced blockage, 358
Geometry-induced blockage loss, 356
Global energy efficiency (GEE), 457
Global positioning system, 503
Guard band, 60
Half-duplex (HD), 373, 377, 397
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-duplex system, 377</td>
</tr>
<tr>
<td>Hammerstein model, 419</td>
</tr>
<tr>
<td>Handover, 499</td>
</tr>
<tr>
<td>Heterogeneous-network (HetNet), 486</td>
</tr>
<tr>
<td>High-definition TV (HDTV), 485</td>
</tr>
<tr>
<td>High-density polyethylene (HDPE), 301</td>
</tr>
<tr>
<td>High-impedance surfaces, 409</td>
</tr>
<tr>
<td>Hybrid automatic repeat request (HARQ), 433</td>
</tr>
<tr>
<td>Hybrid beamforming, 368</td>
</tr>
<tr>
<td>Impairment calibration, 396</td>
</tr>
<tr>
<td>IMT-2020 specifications, 571</td>
</tr>
<tr>
<td>In-band full duplex (IBFD), 373</td>
</tr>
<tr>
<td>In-phase and quadrature (I/Q), 334</td>
</tr>
<tr>
<td>Inbound symbol rate, 346</td>
</tr>
<tr>
<td>Indoor–outdoor penetration loss, 359</td>
</tr>
<tr>
<td>Infrastructure-to-device (I2D), 458</td>
</tr>
<tr>
<td>Inter-carrier interference (ICI), 48</td>
</tr>
<tr>
<td>Inter-cell interference, 491</td>
</tr>
<tr>
<td>Inter-symbol interference (ISI), 8, 13, 15, 19, 57, 84</td>
</tr>
<tr>
<td>Interference alignment, 490</td>
</tr>
<tr>
<td>Interference handling, 369</td>
</tr>
<tr>
<td>Interference management, 486</td>
</tr>
<tr>
<td>Interference rejection combining (IRC), 493</td>
</tr>
<tr>
<td>Internet of things (IoT), 116</td>
</tr>
<tr>
<td>Inverse fast Fourier transform (IFFT), 341</td>
</tr>
<tr>
<td>IQ imbalance, 387</td>
</tr>
<tr>
<td>IQ mismatch, 386</td>
</tr>
<tr>
<td>Joint processing (JP), 487</td>
</tr>
<tr>
<td>Joint quantization, 445</td>
</tr>
<tr>
<td>Joint transmission (JT), 489</td>
</tr>
<tr>
<td>Joule energy efficiency, 457</td>
</tr>
<tr>
<td>Karush Kuhn Tucker (KKT), 465</td>
</tr>
<tr>
<td>KKT properties, 465</td>
</tr>
<tr>
<td>Kronecker model, 443</td>
</tr>
<tr>
<td>Lagrange multiplier, 474</td>
</tr>
<tr>
<td>Least-mean-square (LMS), 413</td>
</tr>
<tr>
<td>Licensed assisted access (LAA), 568, 569, 570</td>
</tr>
<tr>
<td>Line-of-sight (LOS), 199</td>
</tr>
<tr>
<td>Linear convolution, 174</td>
</tr>
<tr>
<td>Long term evolution (LTE), 178</td>
</tr>
<tr>
<td>Lossless compression, 433</td>
</tr>
<tr>
<td>Low pass filter, 555</td>
</tr>
<tr>
<td>Machine-type communication (MTC), 561</td>
</tr>
<tr>
<td>Majorization–minimization (MM), 446</td>
</tr>
<tr>
<td>Massive machine type communications (mMTC), 570</td>
</tr>
<tr>
<td>Massive MIMO, 68, 73, 83, 84, 87, 510</td>
</tr>
<tr>
<td>Matched filtering, 341</td>
</tr>
<tr>
<td>Maximum a posteriori (MAP), 17</td>
</tr>
<tr>
<td>Maximum-ratio combining (MRC), 197</td>
</tr>
<tr>
<td>Maximum-ratio transmission (MRT), 195</td>
</tr>
<tr>
<td>Medium access control (MAC), 518</td>
</tr>
<tr>
<td>Millimeter wave (mmWave), 18</td>
</tr>
<tr>
<td>Minimum mean square error (MMSE), 393</td>
</tr>
<tr>
<td>Mixed integer (MI), 513</td>
</tr>
<tr>
<td>Mixer nonlinearities, 419</td>
</tr>
<tr>
<td>Mobility anchor, 498–499</td>
</tr>
<tr>
<td>Mobility management, 486</td>
</tr>
<tr>
<td>Moore–Penrose pseudo-inverse, 548</td>
</tr>
<tr>
<td>Multi-carrier modulation (MCM), 48, 171, 177</td>
</tr>
<tr>
<td>Multi-cell multicast, 570</td>
</tr>
<tr>
<td>Multi-path channels, 7</td>
</tr>
<tr>
<td>Multi-user shared access (MUSA), 133</td>
</tr>
<tr>
<td>Multiple input multiple output (MIMO), 68, 75, 79, 346, 347, 351</td>
</tr>
<tr>
<td>Narrowband internet of things (NB-IoT), 569</td>
</tr>
<tr>
<td>Network coordination, 487</td>
</tr>
<tr>
<td>Network densification, 484</td>
</tr>
<tr>
<td>Network operation, 485</td>
</tr>
<tr>
<td>Newton’s method, 468</td>
</tr>
<tr>
<td>Non-blockage state, 358</td>
</tr>
<tr>
<td>Non-line-of-sight (NLoS), 358</td>
</tr>
<tr>
<td>Non-orthogonal multiple access (NOMA), 117, 141, 144, 146, 150, 153, 155</td>
</tr>
<tr>
<td>Null cyclic prefix single carrier (NCP-SC), 18</td>
</tr>
<tr>
<td>Nyquist theorem, 383</td>
</tr>
<tr>
<td>Omni-directional channels, 369</td>
</tr>
<tr>
<td>Operating system (OS), 333</td>
</tr>
<tr>
<td>Orbital angular momentum (OAM), 300</td>
</tr>
</tbody>
</table>
Orthogonal frequency-division multiple access (OFDMA), 4, 144, 510
Orthogonal frequency-division multiplexing (OFDM), 4, 6, 48, 55, 58, 185, 563
Orthogonal polarization states, 544
Out-of-band (OOB), 170
Out-of-cluster, 460
Outdoor-indoor relay, 409
Over-the-top (OTT), 485
Overlapping factor, 173
Packet error rate (PER), 216
Passive isolation, 405
Path loss, 355
Peak-to-average-power ratio (PAPR), 5, 6, 19, 74, 151, 541
Peer-to-peer (P2P), 336
Periodic signals, 574
Physical layer (PHY), 333
Pilot contamination, 198
Pilot signal, 435
Polynomial-based systems, 419
Polyphase network (PPN), 8
Power allocation, 440
Power amplifier (PA), 385
Power spectral density (PSD), 30
Power-delay profile, 365
Precision time protocol, 503
Predictive quantization, 433
Primary synchronization signal, 554
Propagation channel, 194
Prototype filter, 7, 8, 173, 174, 183
Pseudo-concavity, 465
Pulse amplitude modulated (PAM), 85
Quadrature amplitude modulation (QAM), 4, 6, 15, 93, 99, 185
Quadrature phase shift keying (QPSK), 33
Quantization, 433
Quantization errors, 407
Quantization noise, 414
Quantization noise floor, 377
Quantization noise matrix, 445
Quasi-concave (QC), 463
Quasi-static, 441
Radio access technology (RAT), 355, 501, 571
Radio frequency (RF), 356
Radio resource control, 495
Radio resource management (RRM), 511
Ray tracing, 365
Ray-propagation-based statistical model, 363
Rayleigh channels, 375
Real-time controller, 557
Reference symbol, 555
Relay antenna, 410
Relay link, 413
Remote radio head (RRH), 433
Residual self-interference, 559
Resource block (RB), 60, 61, 131, 177, 565, 569
RF imperfections, 407
Rice distribution, 476
Root mean square (RMS), 365
Root raised cosine (RRC), 331
S-parameters, 410
Scattered paths, 476
Second-order cone programming, 513
Self-interference (SI), 374
Self-interference cancellation (SIC), 374, 394, 395, 540, 541, 543
Sequential fractional programming, 458
Shannon limit, 31
Signal to noise ratio (SNR), 134
Signal to self-interference plus noise ratio (SSINR), 376
Signal-to-interference-plus-noise ratio (SINR), 71
Single-carrier (SC), 144
Site acquisition, 485
Slow-fading, 476
Small cells, 486
Software defined radio (SDR), 193, 353, 550
Space-time block coding, 174
Sparse code multiple access (SCMA), 131
Spatial channel model (SCM), 359
Spatial-domain suppression, 415
Spectral efficiency, 131
Spectrally efficient frequency division multiplexing (SEFDM), 91
Spectrum confinement, 181
Static blockage, 360
Stochastic gradient descent (SGD), 417
Strict quasi-concavity, 463
Subcarrier mapping, 7
Subcarriers, 91
Synthesis filters, 49

Tactile internet, 4
Tail issue, 180
Tail-biting technique, 11
Tapped delay line, 266
Taylor expansion, 447
Temporal shadow fading, 359
Three-dimensional MIMO (3D-MIMO), 276
Time division duplexing (TDD), 68, 70, 83, 194, 198, 373, 565
Time-division multiple access (TDMA), 48
Time-frequency packing (TFP), 6
Timing synchronization, 331
Toeplitz matrix, 384
Transport blocks, 330
Turbo decoder, 340

Ultra-dense network (UDN), 484, 486, 501, 504, 510, 515
Ultra-reliable and low-latency communications (URLLC), 570

Universal filtered multi-carrier (UFMC), 6
Uplink (UL), 136, 138, 337, 505, 534
Upper-bound minimization, 446
User equipment (UE), 365
User-association, 515
User-to-cell association, 533

Vehicle-to-infrastructure (V2I), 570
Vehicle-to-pedestrian (V2P), 570
Vehicle-to-vehicle (V2V), 570
Virtual cell, 495, 496, 497
Virtual layer, 497–498
Virtual reality, 485
Virtual reality, 485
Volterra series, 386

Weighted minimum energy efficiency, 458
Weighted sum-rate (WSR), 458
Wideband code division multiple access (WCDMA), 48
Wireless backhaul, 501, 503, 504
Wireless regional area networks (WRAN), 4
Wyner–Ziv coding, 454

Zadoff–Chu (ZC) sequence, 554
Zero mean, 437, 450, 476
Zero mean Gaussian process, 16
Zero padding, 97
Zero-forcing combiner, 197