

Index

- algorithm
 - antenna selection, 251, 254, 259, 260
 - beamforming, 233
 - block-diagonalization, 228, 231
 - channel inversion, 211, 220
 - decremental selection, 262, 263
 - distributed primal-dual, 280
 - downlink, 222
 - ESPRIT, 43
 - Gauss-Seidel, 280
 - generalized Lloyd, 331
 - gradient projection, 280
 - incremental selection, 261, 263
 - integer least-squares, 225
 - interference-balancing, 211
 - interior-point, 304
 - iterative water-filling, 280
 - JAFE, 59
 - lattice reduction, 223
 - Lenstra-Lenstra-Lovász, 226, 234
 - Lloyd, 330, 345, 347
 - localized gradient, 58
 - low-complexity selection, 260
 - matrix pencil, 59
 - maximal ratio combining, 233
 - maximum norm based selection, 262
 - MMSE, 233
 - modulo precoding, 222, 223
 - multidimensional folding, 47, 53, 61
 - multiuser MIMO downlink, 217
 - MUSIC, 44, 53, 57
 - power control, 211
 - power control iterative, 280
 - precoding, 225
 - QR-based, 225
 - RARE, 61
 - scheduling, 235, 236
 - selection, 255, 262
 - SIMO/MISO selection, 251
 - sphere, 221
 - subset selection, 254
 - unitary ESPRIT, 55, 56
- amplifier, 25, 31–34
 - design, 32
 - gain, 34
 - input, 31
 - low noise, 245
 - matching, 33
 - noise characteristics, 33
 - noisy, 31
 - output, 31
 - performance, 32
 - power, 225, 245
 - receiver, 29, 30
 - uncoupled, 32
- angle
 - of arrival, 322, 328
 - spread, 322, 328
- angular spread, 27
- antenna
 - aperture, 12, 64, 66
 - array, 1, 15, 24, 62, 328
 - bandwidth, 12
 - base station, 25
 - calibration, 68
 - configurations, 3
 - correlation coefficients, 97
 - coupled, 29

- antenna (*Continued*)
 - coupling, 33, 68
 - decorrelation distance, 79
 - dipole, 27
 - dual-polarization, 28
 - element, 1, 5, 13, 17, 26, 63, 80, 82, 245, 246, 248, 252
 - high-gain, 12
 - impedance, 32
 - loop, 27
 - lossless, 29
 - multibeam, 25
 - multimode, 26
 - multipolarized, 27
 - mutual coupling, 1, 5, 25, 27, 28, 32
 - open-circuit, 29, 31
 - optimal selection, 256, 259, 264
 - optimal set, 259
 - optimally selected, 248, 249
 - polarization, 25
 - radiation pattern, 12, 25, 26, 29, 30
 - receive, 5–9, 12, 17–19, 24, 31, 63, 64, 67, 78–81, 98, 105, 108, 143, 149, 169, 170, 172, 188, 197, 201, 204, 211, 212, 214, 215, 227, 233, 245, 246, 248, 250–252, 254, 255, 259, 261, 262, 265, 301, 319, 322, 323, 338
 - receive selection, 251
 - selection, 245, 246, 248, 250, 251, 254–256, 259, 260, 262, 263, 266
 - selection gain, 248
 - separation, 15
 - spacing, 9, 10, 17, 23, 24, 34, 322
 - steered, 12
 - suboptimal selection, 259, 264
 - subset selection, 245, 254
 - switching, 66
 - system, 24
 - terminals, 3, 29–31
 - transmit, 5–9, 12, 17–19, 63, 64, 67, 78–81, 105, 128, 143, 169, 170, 172, 173, 187, 190, 193, 197, 198, 201, 204, 211–213, 215, 227, 231, 235, 245, 246, 248, 251, 252, 254, 255, 259, 264, 265, 301, 319, 320, 322, 323, 331, 338
 - vector field pattern, 24
 - vertically polarized patch, 22
- array
 - aperture, 13
 - configurations, 5, 14, 25
 - coupled, 30
 - dual, 62
 - dual polarization, 25
 - element, 3
 - loss, 262
 - monopole, 11, 22
 - on the mobile, 25
 - output signal, 31
 - patch, 22, 28
 - processing, 106, 115, 146
 - radiation pattern, 3, 22
 - receive, 2, 3, 10, 41, 63, 65, 67
 - response, 68, 299
 - shape, 25
 - single polarization, 25
 - size, 11
 - switched, 5
 - system, 6
 - topology, 25
 - transmit, 2, 3, 10, 29, 30, 34, 41, 63–65, 231
 - uncertainties, 299
 - uniform circular, 66, 69
 - uniform linear, 64, 69
 - uniform rectangular, 65
 - virtual, 5
- bandwidth, 3, 236, 279
 - antenna, 12
 - constraint, 322
 - efficiency, 153
 - frequency, 20
 - minimal, 235
 - power, 33
 - signal, 63, 66, 69
 - waveform, 4

- base station, 25, 62, 209, 212, 217, 231, 232, 234–236
 - antenna, 235
 - multi-antenna, 278, 300
- beam
 - direction, 347
 - optimal direction, 337
 - random, 235
 - steering, 350
- beamforming, 13, 211, 270, 277, 278, 284, 302, 312, 342
 - adaptive, 159, 350
 - conventional, 340
 - coordinated Tx/Rx, 231, 233
 - finite-rate, 343, 351, 352
 - joint transmit/receive, 236
 - linear, 210, 213, 226
 - linear transmit, 226
 - matrix, 227, 329
 - MIMO, 78, 83, 84, 274
 - minimum variance distortionless response, 277
 - MMSE receive, 232
 - MMSE transmit, 211
 - multiple, 282
 - multiuser, 278
 - nonrobust, 309
 - one-dimensional, 329, 338–341, 345, 350, 351
 - opportunistic, 235
 - optimal directions, 337
 - optimal receive, 211, 232
 - optimal vector, 342
 - optimum, 83
 - power loaded, 333
 - receive, 211, 212, 231, 233, 234, 299
 - regularized transmit, 211
 - robust, 277, 279
 - robust worst-case, 277
 - single, 296, 301
 - transmit, 63, 211, 218, 232, 234, 331, 341, 342, 347, 350
 - transmit-receive, 231, 232, 234, 270, 284
 - two-dimensional, 338–340
 - vector, 338, 342, 348, 350, 352
 - zero-forcing receive, 211, 218
 - zero-forcing transmit, 211
- bipolar junction transistor, 33
- bit allocation, 285, 294
- BLAST, 41, 169, 170, 209, 223, 225
 - MMSE, 225
- bound
 - capacity, 211, 218, 256
 - Chernoff, 178, 179, 181, 285
 - Foschini's, 252
 - pairwise error probability, 179
 - sum capacity, 210
 - symbol error rate, 334, 340, 345
 - union, 134, 135
- capacity, 11, 22, 23, 25, 26, 28, 32, 34, 35, 197, 210, 213–216, 218, 219, 228, 234, 236, 251, 255, 256, 326, 328
 - average, 324, 326, 329, 349
 - bound, 218
 - channel, 177, 248, 251, 252, 256, 260, 270, 279, 308, 328
 - dirty paper, 215
 - distribution function, 228, 233, 250
 - ergodic, 170, 174, 175, 328, 330
 - gain, 251
 - link, 279, 280
 - maximum, 213
 - MIMO, 169, 170, 247, 252, 253, 257, 319
 - MIMO broadcast, 215
 - multiuser, 219, 234
 - multiuser sum, 215
 - network, 210
 - optimization, 329–331
 - outage, 249, 250, 262, 329
 - region, 213, 214, 234
 - Shannon, 251, 259
 - sum, 210, 211, 213, 214, 219, 224, 233, 280
 - system, 105, 211, 215, 219
 - user, 41
 - worst-case, 80
- capacity-optimal transmissions, 323, 324

- CDMA, 77, 157, 223, 291
cellular radio, 63
central limit theorem, 17
channel
 AWGN, 118, 120, 122, 137, 140
 block-diagonalization, 227, 236
 broadcast, 209, 210, 215, 234, 235
 capacity, 5, 9, 10, 17, 22, 77, 177, 197, 248, 251, 252, 255, 256, 260, 270, 279, 308, 328, 349
 capacity bounds, 17
 characteristics, 322
 correlated, 79, 124
 correlated Rayleigh, 126
 correlated Rayleigh fading, 347
 correlation, 322
 covariance, 210
 delay profile, 66
 delay spread, 5
 diagonalization, 234
 diagonalizing, 211
 diversity, 251
 double-directional, 11, 13, 42, 64
 downlink, 210, 216
 downlink covariance, 322
 eigenmode, 270, 288, 290, 291, 297
 ergodic, 80
 estimate, 151, 152, 299
 estimation, 8, 13, 146, 147, 149, 235, 299
 excess delay, 65
 fading, 77–80, 88, 101, 105, 124, 169, 170, 216, 297, 301, 319
 feedback, 8, 212, 217, 299, 307, 308, 320, 322, 329, 347, 352
 flat block fading, 106, 118, 143
 flat fading, 4, 108, 114, 118, 216, 246, 299
 frequency-flat, 79, 349
 frequency nonselective, 4
 frequency-selective, 3, 4, 216, 269, 299, 349
 frequency-flat fading, 319
 gain, 19
 Gaussian interference, 216
 identifiability, 150
 ill-conditioned, 218, 220
 impulse response, 3, 20, 30, 64, 65, 67, 70
 indoor, 20
 inversion, 211, 217–219, 222, 223, 228, 232, 236
 keyhole, 18
 line-of-sight, 79
 linear time invariant, 246
 low-rank, 211
 matrix, 3–5, 10, 11, 14, 17, 18, 22, 30, 79, 81, 113–115, 119, 135, 146, 159, 172, 174, 222, 223, 255, 259, 265, 281, 282, 290, 300, 323, 324, 329
 measured, 10, 11, 22
 measurement, 5, 11, 13, 17
 MIMO, 286, 295, 296, 300, 307
 ML estimate, 7
 ML inversion technique, 7
 model, 4, 13, 41, 42, 62, 63
 modeled, 11, 22
 modeling, 17, 29, 269
 multiantenna, 296, 299
 multipath, 11
 multiple access, 210, 235, 280
 multiuser, 211, 217
 multiuser downlink, 210
 mutual information rate, 77
 narrowband, 216
 non-line-of-sight, 79
 nonergodic, 80
 path loss, 5
 pinhole, 18
 power gain, 5
 precoding, 217
 probing, 6
 quasi-static, 216
 random fading, 254
 rank-deficient, 18, 218
 Rayleigh, 78–80, 89, 94, 96, 119, 121, 122, 126–128, 131, 222, 247, 251, 255
 reciprocity, 299, 307
 regularized inversion, 217–220, 222, 236

- response, 64
- Rician, 78, 80, 88, 94, 95, 101, 119, 121–123, 128–131
- semicorrelated, 79, 96
- sounding, 42, 53, 65, 66
- state information, 81, 82, 119, 145, 154, 161, 178, 187, 210, 211, 216, 217, 226, 232, 234–236, 270, 298–301, 308, 309, 319–324, 326, 328, 331, 332, 334, 344, 345, 347, 348, 352
- stationarity, 18
- time-invariant, 18
- time-varying, 5, 65, 216, 235, 321
- tracking, 236
- transfer function, 4, 11
- transfer matrix, 3, 7, 12, 22
- uncorrelated, 79, 126
- uncorrelated Rayleigh, 119, 133
- uplink covariance, 322
- variation, 3, 8
- vector, 14, 82, 148, 149, 152, 153, 320
- wideband, 216
- code
 - Alamouti's, 105, 128, 142–144, 149, 157, 161, 299, 337
 - amicable design, 105, 149
 - binary, 8
 - convolutional, 264
 - correlating, 6
 - cyclotomic diagonal linear space-time, 193
 - cyclotomic diagonal space-time, 171
 - cyclotomic linear dispersion, 197
 - diagonal space-time, 170, 193
 - dirty paper, 223
 - full diversity, 170, 171, 194, 200
 - full diversity linear dispersion, 171, 192, 194, 195
 - full diversity rectangular linear dispersion, 204
 - full diversity space-time, 197
 - full length, 6
 - full rate, 170, 171, 197, 200
 - Gamal and Damen's, 203
 - Gaussian, 270
 - generalized orthogonal design, 149
 - information lossless, 170, 171
 - length, 7, 8, 236
 - linear cyclotomic, 197
 - linear diagonal space-time block, 197
 - linear dispersion, 134, 144, 145, 170, 172–174, 177, 179, 181, 184, 187, 188, 193, 195, 197, 200, 301
 - linear dispersion space-time, 204
 - linear space-time block, 170, 173, 181, 197, 204
 - linear unitary, 134
 - low density parity check, 234
 - ML, 203
 - nonsquare space-time, 171
 - orthogonal design, 105
 - orthogonal linear dispersion, 187
 - orthogonal space-time block, 170, 183, 299
 - rate, 143
 - Rekaya, Belfiore and Viterbo's, 203
 - repeat-accumulate, 234
 - space-time, 3, 171, 178
 - space-time block, 170, 171
 - space-time orthogonal, 105
 - space-time trellis, 105, 170
 - synchronization, 6, 7
 - trace-orthogonal, 174, 182, 183, 191, 197, 204
 - trace-orthogonal linear dispersion, 182, 187, 188, 190–192, 194
 - trace-orthogonal linear triangular space-time block, 198
 - trace-orthogonal space-time, 200, 203
 - transmit, 6
- codebook, 330, 342
 - beamformer, 345, 347
 - design, 347
 - Gaussian, 81
 - of beamforming vectors, 342
 - size, 343

- codeword, 331
 - probability, 331
 - space-time, 331
 - STBC, 335, 336
- coding, 212, 216, 236
 - differential space-time, 146, 155
 - dirty paper, 211, 215, 219, 220, 223, 225, 234
 - gain, 197, 199, 200, 205
 - interference-depending, 220
 - multiantenna multiuser, 234
 - nested lattices, 234
 - orthogonal space-time block, 331
 - space-time, 13, 41, 105, 111, 146, 187, 270, 319, 323, 331, 352
 - space-time block, 105, 157
- coding-beamforming, 337, 338, 347
- constellation, 119–121, 123, 126, 130, 134–138, 142, 144–146, 149, 170, 171, 178, 179, 193, 198, 202, 204, 212, 216, 270, 285, 294, 333
 - M*-ary QAM, 283
 - 16-QAM, 223, 339
 - 2-PAM, 222
 - average energy, 123
 - biorthogonal, 128
 - BPSK, 143, 144, 149, 282, 294
 - constant modulus, 151, 152
 - design, 140
 - dimension-constrained, 135, 140
 - energy, 143
 - fixed, 294
 - GMSK, 282
 - large-size, 134
 - largest minimum distance, 139, 141
 - matrix, 134, 142
 - members, 134
 - MPSK, 152
 - multidimensional, 128
 - multidimensional OSTBC, 134
 - nonseparable, 111, 119, 128, 143
 - optimal, 133, 137, 138, 141–144, 349
 - PAM, 171
 - point, 140, 152, 159, 221
 - PSK, 344, 345
 - QAM, 171, 282, 295, 348, 350
 - QPSK, 126, 128, 149, 161, 294, 297, 339, 345
 - regular simplex, 134, 141, 142
 - scaling, 137
 - selection, 349
 - separable, 111, 116, 119
 - shape, 118, 147
 - simplex, 128, 132
 - size, 134, 144, 323, 335, 337, 347
 - small-size, 134, 141, 143
 - space invariance, 106, 111, 115, 116, 118, 119, 163
 - space-time, 133, 134, 144
 - two-dimensional, 345
 - unitary, 134
 - vector, 110
- convertor
 - analog-to-digital, 245
- correlation, 343
 - frequency, 296
 - matrix, 44, 119, 128, 322
 - receive, 9, 10, 17, 18, 25, 128
 - spatial, 296
 - transmit, 9, 10, 17, 18, 128, 336
- correlation matrix
 - channel, 337
 - receive, 322
 - transmit, 322
- covariance
 - channel, 210
 - full, 15
 - interference, 213
 - matrix, 14–18, 26, 81, 97, 147, 153, 159, 172, 174, 178, 214, 278, 281, 321, 322, 325, 327, 328
 - one-sided, 329
 - receive, 79
 - shift-invariant, 15
 - transmit, 79
- covariance matrix
 - array, 299
 - channel, 321, 328
 - data, 147
 - interference-plus-noise, 301

- noise, 280
- optimal, 329
- receive, 14, 15, 18
- sample, 151, 152, 161
- transmit, 14, 15, 18, 33, 280
- true, 151, 161
- Cramer-Rao bound, 59
- criterion
 - average capacity, 329
 - capacity, 256, 330
 - code design, 105
 - determinant, 179
 - maximum capacity, 255
 - minimum average BER, 294
 - MMSE, 218
 - orthogonality, 235
 - rank, 179
- decoder, 119
 - blind, 155
 - blind OSTBC, 106
 - coherent ML, 106, 110, 111, 115–117, 135, 155
 - differential, 106, 155
 - incoherent (blind), 115
 - incoherent ML, 155, 163
 - ML, 105, 111, 115, 116, 118, 119, 133, 135, 145, 163
 - nearest neighbor, 146
 - optimal ML, 145, 146
 - space-time, 3
 - symbol-by-symbol, 145
- decoding, 117, 152, 222, 234
 - algorithm, 146, 152
 - blind, 145, 152, 155–157
 - complexity, 105
 - equation, 117
 - formulae, 116
 - incoherent, 163
 - optimal linear, 332
 - optimal ML, 116, 130
 - OSTBC, 152
 - space-time, 157
 - symbol-by-symbol, 115, 116, 130
 - symbol-by-symbol ML, 106
 - unambiguous, 221
- degrees of freedom, 71, 121, 125, 161, 247, 253, 307
 - spatial, 26, 27
 - total, 169
- delay
 - channel excess, 65
 - feedback, 320
 - profile, 67
 - spread, 62
- demapper
 - soft, 264
- demultiplexing
 - spatial, 227
- detection
 - error, 177
 - ML, 119, 178, 283, 303
 - ML symbol, 153
 - multiuser, 159, 210
 - symbol, 153, 155
- detector
 - ML, 169, 170, 178, 179, 187, 197, 205, 300–302
 - MMSE, 184, 187, 203, 204
 - symbol-by-symbol, 160
- DFT, 291
- diagonal loading, 159, 278
- digital pattern generator, 6
- digital subscriber line, 223
 - wireline, 269
- dipole
 - coupled, 33
 - half-wave, 33
 - spacing, 34
- direction
 - of arrival, 12, 20, 42, 63, 64, 236
 - of departure, 12, 20, 42, 63
- diversity, 245, 249, 254, 257, 259
 - angle, 25, 26
 - benefit, 248
 - branch, 343, 344
 - channel, 251
 - combining, 41, 77, 101
 - frequency, 234, 236
 - full, 170, 179, 182, 192, 193, 195, 197, 198, 202, 225, 251, 254, 265, 331

- diversity (*Continued*)
 - gain, 234, 245, 254–257, 259, 265
 - maximum, 179
 - multiuser, 234–236
 - order, 132, 249, 250, 253
 - pattern, 26
 - polarization, 25, 26
 - space, 169
 - spatial, 25, 28, 234, 236, 269
 - temporal, 234, 236
- downlink, 232
 - training data, 217
- DTFT, 7
- duplex
 - frequency-division, 210, 212, 217, 235, 307, 312, 322
 - time-division, 210, 212, 217, 231, 235, 299, 307, 311, 322
- eigen-beamforming, 337, 340
- eigendecomposition, 176, 325, 332
- eigenvalue decomposition, 33, 50
- encoder
 - space-time, 2, 113
 - sphere, 219, 222, 223
- encoding, 234
 - OSTBC, 112
 - sphere, 217, 219, 221–223
- entropy
 - constraint, 331
- environment
 - dense urban, 21
 - fading, 248, 250
 - flat fading, 212
 - forested, 19
 - indoor, 8, 21, 27
 - interference, 220
 - lack-scattering, 79
 - MIMO, 177
 - multipath, 216
 - outdoor, 25
 - random fading, 249
 - rich scattering, 79
 - Rician fading, 14
 - suburban, 69
 - urban, 27, 66
 - WLAN, 264
- equalizer
 - linear, 281
 - MMSE, 183, 187
 - zero-forcing, 183
- error probability, 119, 122, 124, 130, 134, 299
 - analysis, 119, 124
 - average pairwise, 134, 178
 - averaged, 120, 130
 - bit, 184, 204, 294
 - pairwise, 119, 135, 169, 178, 179, 198, 200
 - pairwise worst-case, 179, 205
 - symbol, 126, 187, 222, 283
 - union bound, 134, 135
- error rate, 249
 - bit, 183, 184, 187, 210, 229, 230, 282–286, 294–297, 299, 300, 312, 347, 348, 350, 351
 - block, 132, 143
 - minimum, 260
 - packet, 264, 265
 - symbol, 25, 121, 122, 124, 126, 128, 129, 155, 163, 219, 333, 334, 338–340, 344–347
- estimate
 - capacity, 23
 - channel, 8, 217, 299
 - frequency, 7
 - ML, 7
 - MMSE Bayesian channel, 307
 - phase, 7
 - symbols, 3
 - transfer matrix, 7
- estimation
 - blind, 146, 147, 151, 155
 - channel, 8, 13, 146, 147, 149, 151, 153, 155, 235, 299
 - DOA, 46
 - frequency, 46
 - semiblind, 149
 - timing, 46
- estimator
 - blind, 154
 - blind ML, 153
 - Capon, 153

- channel, 154
 - ESPRIT, 13
 - ML, 12, 154
 - MMSE, 321
 - MUSIC, 58, 153
 - RARE, 53, 58
 - subspace parametric, 13
- fading, 41, 62, 250, 291, 297
- block, 109
 - correlated Rayleigh, 126, 347
 - correlation, 79, 97, 98
 - flat, 4, 105, 108, 212, 216, 246, 299
 - flat block, 106, 118, 163
 - flat Rayleigh, 255
 - frequency flat, 81, 319, 349
 - frequency-selective, 3, 62, 216, 256
 - Nakagami, 336
 - nonselective, 246
 - quasi-static, 216
 - random, 249, 254
 - Rayleigh, 14, 79, 81, 94, 119, 122, 127, 222, 247
 - Rayleigh flat, 133
 - Rician, 14, 79, 80, 88, 93–95, 121–123, 128–131, 336
 - slow, 319
 - spatial correlations, 322
 - time selective, 62
 - uncorrelated Rayleigh, 133
- FDMA, 235
- feedback, 210
- bit, 322, 323, 342, 343, 350
 - channel, 8, 212, 299, 307, 308, 320, 322, 329, 347, 352
 - covariance, 321, 322, 325–328, 334, 336–338, 340
 - delay, 320
 - delayed, 321, 326
 - errors, 320
 - finite-rate, 322, 323, 331, 341–345, 350–352
 - imperfect, 234
 - information, 320
 - limited, 235
 - mean, 321, 325, 328, 334, 335, 337, 338, 348, 349
 - MIMO covariance, 329
 - MIMO mean, 329
 - MISO covariance, 328, 329
 - MISO mean, 325, 326, 329
 - outdated, 234
 - received, 321
- FFT, 6, 7, 60
- filter, 264
- design, 277
 - FIR, 277
 - interpolation, 66
 - linear, 302
 - matched, 3, 4, 117, 145, 157, 247
 - MMSE, 265
 - moving average, 7
 - optimal MMSE, 264
 - pulse shaping, 2
 - Wiener, 284
 - zero-forcing, 218
- finite alphabet
- constraint, 153–155
- forward-backward averaging, 49
- Fourier
- discrete time transform, 7
 - discrete transform, 291
 - fast transform, 6, 7, 60
 - multidimensional transform, 53
 - resolution limit, 42
 - transform, 3, 64, 67, 70, 80
- frequency
- band, 216
 - bandwidth, 20
 - calibration, 322
 - carrier, 4, 7, 63, 66, 69
 - center, 6
 - domain, 47, 65, 264
 - Doppler, 64, 321
 - Doppler shift, 63
 - hopping, 46
 - interleaving, 264
 - intermediate, 6, 7
 - reference, 66
 - response, 66
 - selectivity, 62
 - subcarrier, 264

- identifiability
 - bound, 47, 53
 - deterministic, 47
 - stochastic, 47, 51
 - sufficient conditions, 47
 - with probability one, 47
- impedance
 - characteristics, 29
 - matrix, 32
 - mutual, 29
 - self-impedance, 34
 - termination, 29
- inequality
 - Cauchy-Schwarz, 278
 - Fisher, 175
 - Hadamard, 180, 327, 337
 - Jensen, 176, 177, 184, 186
 - Minkovski, 199
 - triangle, 278
- interference
 - balancing, 210, 217
 - cochannel, 81
 - intersymbol, 216
 - interuser, 210, 211, 218, 227, 228
 - multiaccess, 159–161
 - self-interference, 160, 161, 163
 - semicorrelated Rayleigh, 81
 - spatial, 217, 227
- interleaving
 - frequency, 264
 - space-frequency, 264
- joint diagonalization, 13
- LAN, 216
 - wireless, 262
- line-of-sight, 69, 128
 - component, 14
- local area network, 216
- local oscillator, 6
- LOS, 128
- maximal ratio combining, 83–85, 94, 95, 232, 245, 247, 248, 250–252, 344
- measurements
 - angle of arrival, 22
 - channel, 11, 13, 17
 - channel sounding, 42
 - MIMO sounding, 62
 - MIMO system, 6
 - real-time, 65
 - transfer matrix, 22
 - transmit-receive, 66
 - urban, 17
- method
 - barrier, 277
 - bisection, 286
 - block-diagonalization, 228
 - Capon, 277
 - cutting-plane, 276
 - ellipsoid, 276
 - finite-difference time-domain, 33
 - gap-approximation, 285, 294
 - interior-point, 270, 276
 - primal-dual interior-point, 277
 - steepest descent, 304
- microcells, 24
- MIMO
 - antenna selection, 245, 251, 254, 259, 262, 265
 - beamforming, 83–85, 274
 - broadcast, 209, 210, 234, 235
 - capacity, 24, 28, 29, 32, 33, 169, 170, 247, 252, 253, 257, 319
 - channel, 2, 13, 14, 18, 41, 42, 62–64, 78, 170, 269, 284, 286, 295, 296, 300, 307
 - channel characteristics, 24
 - channel model, 63
 - channel sounding, 53, 65, 66, 70
 - downlink, 210, 216
 - eigenmodes, 18
 - measurements, 6
 - modeling, 15
 - multiaccess, 106, 157–159, 161, 163
 - multiantenna, 269
 - multiple access, 210, 235
 - multiuser, 213, 214, 216, 223

- multiuser channel, 149
- multiuser downlink, 209, 212, 217, 236
- multiuser network, 210
- narrowband system, 6
- noncoherent system, 171
- OFDM, 245, 262, 264, 349
- optimum combining, 85, 100
- orthogonally-coded system, 106
- performance, 6, 22, 24–26
- point-to-point, 106, 157, 209, 215, 280
- single-user, 210, 213, 216
- space-time adaptive links, 63
- system model, 2
- uplink, 210
- WLAN, 266
- minimum description length, 13
- minimum distance, 126, 221
- mobile station, 66, 67, 235
- model
 - array processing, 115
 - cluster, 20
 - double-directional, 42, 63
 - equivalent discrete-time, 172
 - fitting, 63
 - Jakes', 10, 17, 321
 - Kronecker-product, 79
 - parametric, 62
 - path-based, 14, 17, 30
 - plane-wave, 13
 - point-to-point MIMO, 106
 - Saleh-Valenzuela, 20–23, 34
 - two-ring, 19
- modulation
 - adaptive, 347, 348, 350, 352
 - BPSK, 6
 - coded, 349
 - constellation, 6
 - fixed, 347
 - multicarrier, 299
 - OFDM, 264
 - PAM, 222
 - PSK, 333
 - QPSK, 187, 204
 - rectangular QAM, 333
 - square QAM, 333
 - uncoded, 349
- multidimensional harmonic retrieval, 42, 43, 53, 57, 61
 - identifiability, 46
- multiplexing, 212, 254, 259, 266, 269
 - frequency, 231
 - gain, 245, 254–256, 259, 265
 - MMSE, 265
 - orthogonal frequency division, 216
 - spatial, 209, 231, 235, 251, 254, 264, 352
 - time, 228
- mutual information, 33, 79, 80, 82, 94, 97, 100, 175, 299, 324, 326, 329, 352
 - averaged, 330
 - conditioned, 324
 - maximization, 293
 - upper bound, 176
- network, 29
 - ad hoc, 235, 236
 - ad hoc wireless, 280
 - analysis, 31
 - array combining, 32
 - cellular, 235
 - flow, 279
 - impedance transforming, 32
 - link, 280
 - matching, 30–32, 34
 - model, 4, 29
 - modeling, 28
 - multicommodity flow, 279
 - multihop, 280
 - multiport matching, 31
 - nodes, 236
 - optimal routing, 279
 - optimization, 279
 - performance, 279
 - resource allocation, 279
 - routing, 279
 - uncoupled, 32
 - utility, 280
 - wireless, 236, 278, 279

- NLOS, 79, 128
- non-line-of-sight, 128
- OFDM, 216, 245, 262, 264
 - subcarrier, 349
- OSTBC, 105, 106, 109, 110, 112–115, 118–120, 126, 134, 135, 140, 141, 144, 145, 149, 153, 154, 157, 161, 163, 299, 301–303, 309, 311, 312
 - decoder, 106
 - full-rate, 155
 - matrix, 112
 - optimality, 106, 133, 134, 140, 141, 144
 - suboptimality, 134
- outage, 300
 - BER, 296
 - capacity, 249, 250, 262, 329
 - probability, 77, 80, 101, 254, 329, 349
 - rate, 249, 250, 259, 262, 265
 - region, 250
- path loss, 63
 - time-varying, 63
 - variation, 24
- power allocation, 288, 290, 302, 305, 312, 347
 - equal, 340
 - maximin robust, 306
 - optimal, 287, 302, 312, 340
 - profile, 309
 - robust, 305, 312
 - uniform, 293
- power control, 217, 226, 228
 - downlink, 210
 - dual, 226
- power loading, 335
 - equal, 340
 - optimal, 228, 339, 340
- precoder, 173
 - linear, 150, 281
- precoding, 217, 223
 - linear, 331, 339, 340
 - matrix, 337, 347
- MMSE Tomlinson-Harashima, 228–231
 - modulo, 222, 223
 - nonlinear, 210, 222
 - regularized vector, 223
 - sphere, 221
 - Tomlinson-Harashima, 223, 228
 - unitary, 332
 - vector, 220, 221, 223, 226, 234
 - vector modulo, 211, 222
- propagation loss, 11
- QoS, 210, 211, 226, 307, 309
 - constraint, 210, 211, 285–287, 289, 295, 297, 303
- quality of service, 41, 210
- quantization
 - sphere vector, 347
 - vector, 323, 330, 331
- ray-tracing
 - predictions, 24
 - simulations, 20, 24, 322
 - techniques, 24
- receiver
 - Capon-type, 157
 - coherent, 119
 - coupling, 34
 - decision feedback, 281
 - decorrelator, 117, 157, 160
 - diagonal loading based, 159, 163
 - diagonally loaded minimum variance, 161
 - front-end, 3
 - informed, 154
 - linear multiuser, 157
 - matched filter, 117, 146, 157, 159, 160, 163
 - minimum output energy, 159
 - minimum variance, 106, 115, 159–161, 163
 - ML, 146, 151, 152, 154, 157, 281
 - MMSE, 183, 284, 297
 - multiantenna, 157, 158, 210, 227, 236
 - optimum linear, 298

- robust minimum variance, 161
- zero-forcing, 117, 284, 297
- reciprocity
 - transmitter-receiver, 120
 - transmitter-receiver, 126
- recovery
 - carrier, 6, 7
 - frequency, 264
 - timing, 6, 7, 264
- scattering, 41
 - cross-section, 19
 - diffuse, 13
 - discrete model, 19, 23
 - far-field, 12, 15
 - local, 23
 - long-range, 18
 - multipath, 17
 - non-line-of-sight, 79
 - rich, 79
- scheduling, 235
 - multiuser, 236
 - proportional fair, 235
- SDMA, 210, 235
- shadowing, 42
- Shur decomposition, 57, 59
- signal
 - analog-to-digital conversion, 6
 - despreading, 7
 - downconversion, 6
 - filtering, 6
 - hopping, 236
 - matched filtering, 13
 - sampling, 6
 - self-nulling, 161
- signaling
 - 16-QAM, 219
 - capacity-achieving, 270
 - Gaussian, 270
 - PAM, 222
 - QPSK, 222
- singular value decomposition, 32, 50, 223
- spatial signature, 24
- spectrum
 - analog, 215
 - delay-Doppler, 67
 - Doppler, 67
 - efficiency, 41, 269
 - time-frequency, 67
- STBC, 105, 109, 134, 182, 331, 332, 337, 339, 340, 345, 347
 - codeword, 335, 336
 - linear, 188
 - linear dispersion, 199
 - matrix, 331, 332
 - trace-orthogonal, 183
- synchronization
 - carrier, 65
 - timing, 65
- TDMA, 235
- throughput, 249, 260
 - latency, 210
 - network, 211
 - penalty, 210
 - system, 319, 352
- transceiver, 264, 296
 - adaptive, 351
 - design, 323
 - linear, 280, 281
 - linear MIMO, 282, 296, 312
 - MIMO, 265, 270, 280, 282, 284
 - multiantenna, 347
- transmitter
 - adaptation, 348
 - adaptive, 349
 - array, 328
 - multiantenna, 157, 158, 209, 299
 - optimal design, 319
 - optimum linear, 298
 - robust, 300, 301
 - robust design, 298
- uplink
 - training data, 231
- water-filling, 10, 22, 33, 81, 228, 293, 296, 319, 327, 337
 - iterative, 274, 280
 - power profile, 270
- WLAN, 262, 264
- zero-forcing, 160, 163, 218, 284, 285