

Index

- AAS, Adaptive Antenna System 465
absorption 3, 140, 142, 146, 149, 154, 158, 285,
297, 357, 370–372, 384
adaptive antenna(s) 22, 201, 321, 386, 437–439,
441, 442, 445, 450, 452, 465, 466, 499
adaptive array 437, 440, 441, 449
adaptive equaliser 419
additive white Gaussian noise (AWGN) 210
AI, Air Interface 9, 435
air interface 9, 435
aliased 415, 416
AMPS, Advanced Mobile Phone System 6
anisotropic 151, 152
antenna arrays 77, 453, 464
antenna height 8–10, 99, 101, 102, 107, 111, 112,
164, 165, 167–170, 173, 174, 176, 182, 187, 189,
191, 259, 261, 265, 267, 268, 270, 272, 278, 379,
384, 397, 488, 492
AoA, Angle of Arrival 463
AoD, Angle of Departure 463
aperture 71, 72, 82, 97, 139, 149, 151, 161, 298, 362
AR, Axial Ratio 32
Argand diagram 216
ARQ, Automatic Repeat reQuest 20
array factor 78, 79, 81, 82
array manifold 445
atmospheric effects 2, 7, 331
atmospheric refractivity 108
attenuation constant 29, 30, 41
attenuator 96, 323, 482, 483
autocorrelation 197, 198, 236, 237, 345, 347, 395,
477, 478, 480
average fade duration 233–235, 340
axial ratio 32, 33, 44, 375
back lobe 66
bandpass signals 209
bandwidth 17–20, 70, 83, 84, 93, 94, 102, 159,
209–211, 229, 230, 233, 241, 243, 246, 251, 252,
254, 302, 303, 313, 316, 320, 361–364, 368, 403,
411, 415, 426–429, 431, 435, 455, 460, 462, 478,
480, 500
baseband 9, 17, 19, 209–212, 215, 238, 320, 437,
470
beamwidth 66, 71, 132, 308, 361, 374, 376, 382,
384, 385
Bello function(s) 252, 253
BER, Bit Error Rate 8, 212, 240
binary phase shift keying (BPSK) 19, 212
bit error rate (BER) 8, 20, 212, 213, 219, 225, 245,
249, 408, 409, 427
blocked 8, 13, 15, 50, 215, 270, 333, 349
Boltzmann's constant 93
boresight 66, 400
Bouger's law 109
BPSK, Binary Phase Shift Keying 19, 212
branch 391, 392, 397, 402–409, 424, 437, 443, 445,
449, 450
breakpoint 258–260, 264, 267, 268, 272, 274, 290,
307

- BS, Base Station 187
 BSC 9
 BSC, Base Station Controller 9
 BSS 9, 13
 BSS, Base Station Subsystem 9
 BTS 9, 323
 BTS, Base Transceiver Station 9
 bursts 18, 236, 238, 420
 busy hour 14
- canonical problems 57
 canting angle 152
 capacity 2, 8, 12, 14, 16, 20, 22, 165, 197,
 200, 201, 205, 259, 278, 283, 293, 309, 312,
 320, 321, 324, 354, 372, 379, 397, 402, 420,
 433, 437, 440, 441, 443, 454–462, 464–466,
 499, 500
 Cassegrain 160, 161
 Causebrook correction 116, 119
 cdf, cumulative distribution function 350
 CDMA, Code Division Multiple Access 6, 17–19,
 434
 cell radius 8, 10, 190, 192, 268, 440, 486, 487
 centra imit theorem 189, 215
 channel transfer function 243, 251
 chip 18, 427, 428, 430
 CINR, Carrier to Interference plus Noise Ratio
 CIR, Carrier to Interference Ratio 200, 204, 259,
 495
 circularly polarised 32, 376
 classical Doppler spectrum 230–232, 234, 235, 239,
 249, 252, 300, 341
 cluster 10, 12, 303, 462–464
 clutter 10, 105, 134, 163, 165–168, 170, 172, 179,
 183, 187, 191, 195, 202, 264, 266, 267, 278, 303,
 309, 321, 332, 354, 368, 472, 487, 488
 clutter factor 165, 166, 170, 172, 179, 191
 cm, centimetre(s) 5
 code division 17–19, 427
 coding 11, 20, 254, 435, 441, 459, 460, 462, 466,
 498, 499
 coherence bandwidth 251, 252, 254, 403, 411, 428,
 480
 coherence time 237, 238, 411, 420, 422, 434, 481
 complementary cumulative normal distribution
 190, 318
 complementary error function ****
 completely polarised 33, 34
 complex baseband 209–212, 215, 437
 complex Gaussian random variable 216, 217,
 457
 conductivity 28, 29, 41, 43, 45, 100, 129, 268, 352,
 371, 372
 conductor 30, 41, 57, 77, 80, 129, 132, 365, 368
 constitutive parameter(s) 29, 30, 34, 37, 41, 42,
 47–49, 129, 132, 164, 265, 266, 270, 297,
 299, 300
 continuous wave (CW) 215, 414, 479
 convergence speed 419
 Corazza model 339, 341
 correlated shadowing 196, 198, 199
 correlation coefficient 356, 393, 396, 397,
 399–401, 480
 correlation matrix 419, 420, 444, 445, 447, 450, 451
 cosmic 2, 154
 cosmic radiation 2
 coverage probability 193, 472
 CP, Circular Polarisation 32
 critical frequency 158
 cumulative distribution function (c.d.f.) 218
 curl 25, 26, 131
 current distribution 63, 71, 73–77, 375
 CW, Continuous Wave (or Carrier Wave) 215, 479
 cylinder 127, 128
 cylinder loss 128
- DAS, Distributed Antenna System 310
 dB, decibel(s) 92
 dead reckoning 486
 decision feedback equaliser 423
 decorrelation 198, 402, 455, 461
 DECT, Digital Enhanced Cordless
 Telecommunications (originally Digital Eur-
 opean Cordless Telephone) 6
 delay range 243–245, 302
 delay spread 244–254, 277, 278, 300–303, 310, 314,
 353, 354, 384, 415, 416, 422, 424, 425, 431, 432,
 440, 452, 461, 462, 464, 480
 depolarisation 151–153
 depth of coverage 8, 283, 293
 despreading 18, 19, 430
 Deygout method 115–117
 DFE 423
 DFE, Decision Feedback Equaliser 423
 dielectric 30, 40, 41, 67, 84, 85, 297, 306, 362, 365,
 367, 368, 372, 380
 diffraction 3, 50–59, 73, 106, 114–116, 118–129,
 135, 170, 172–181, 183, 257, 268–275, 288–292,
 298, 334, 344, 348, 350, 351, 399, 498
 coefficients 39–45, 47, 49, 50, 56, 57, 80, 122,
 265, 278, 288, 290, 294, 334, 379, 393, 399, 400,
 406, 416, 417, 419–422, 439

- parameter 52–54, 102, 114, 115, 122, 125, 126, 156, 158, 163–165, 170, 172, 176, 179, 181, 194, 212, 222, 226, 261, 269, 295, 325, 346, 348, 349, 379, 421, 463, 480
- digital signal processing (DSP) 13, 499
- direct matrix inversion 420, 426
- direct sequence 18
- directivity 67, 68, 71, 74, 77, 78, 80, 106, 362, 368, 376
- dispersion 159, 254, 302, 303, 425, 432, 454, 463
- distributed antenna system 310–315, 317, 322, 499
- distributed antennas 310
- disturbance 50, 361, 415, 418, 424
- diversity combiner 391, 403
- diversity gain 19, 103, 356, 376, 385, 397, 399, 402, 404, 408, 429, 430, 449, 458
- Doppler bandwidth 229, 230
- Doppler effect 228
- Doppler shift 229–232, 239, 332, 356, 357
- Doppler spectrum 230–235, 239, 249, 252, 253, 300, 301, 312, 341, 354
- Doppler spread 229, 230, 232, 236, 237, 239, 253, 332, 357, 461, 462
- downlink 17, 18, 102, 200, 311, 312, 324, 397, 430, 438, 440, 450
- downtilt 376–378
- drop size 142
- DS-CDMA, Direct Sequence Code Division Multiple Access ****
- ducting 111–113, 135
- duplexing 427
- duplex spacing 17
- duplexers 17, 18

- Earth bulge 106, 107, 109, 111, 139
- effective Earth radius factor 109, 112, 135
- efficiency 10, 13, 19, 67, 68, 71, 77, 82–84, 161, 361–363, 380, 386, 402, 430, 449
- electric field 25–27, 30, 32, 33, 37, 39, 41, 42, 72, 84, 130, 146, 152, 153, 157, 289, 371, 372, 399
- electromagnetic spectrum 4, 5
- electromagnetic waves 1, 21, 25
- elliptically polarised 32
- empirical model 142, 164–166, 171, 172, 179, 183, 188, 250, 257, 259, 262, 264, 267, 272, 273, 283, 286–288, 294, 295, 309, 336, 346, 498
- empirical roadside shadowing (ERS) 336
- endfire 395
- equalisation 18, 22, 245, 249, 310, 311, 386, 420, 424–427
- Ericsson model 286
- erlang 13, 14, 16
- error floor 245, 254, 416
- error function 190
- error propagation 423
- Euclidean distance 212
- excess delay 247, 248, 254, 354, 432, 451, 454
- excess loss 98, 114, 116, 117, 135, 172, 298
- expectation 34, 344, 393, 394, 424
- extraterrestrial 154, 155
- fade margin 101–103, 105, 112, 145, 160, 189, 190, 192, 194, 357, 472, 498

- Faraday rotation 158
- fast fading 3, 4, 22, 89, 164, 209, 227, 241, 254, 309, 332, 333, 336, 449, 450, 469, 473, 478, 480, 486
- FDD, Frequency Division Duplex 17
- FDMA, Frequency Division Multiple Access 18
- FEC, Forward Error Correction 20
- feedback filter 423
- feedforward filter 423
- Fermat's principle 38
- field strength 25, 29, 30, 51, 52, 92, 99, 121, 129, 131, 163, 168, 173, 174, 176, 291, 292, 323, 374
- finger 429
- finite-difference time-domain (FDTD) 289, 381
- first Nyquist criterion 415–417, 478
- Fourier transform 132, 236, 251, 252, 394, 415, 431
- fractionally spaced equaliser 416
- frames 18, 290
- Fraunhofer region 63
- free space loss 97–101, 113, 114, 116, 135, 139, 164, 165, 178–180, 264, 285, 294, 306, 332, 333, 357
- frequency diversity 403, 413, 426
- frequency division 17, 254
- frequency management ****
- frequency modulation 17
- Fresnel ellipsoid 111, 115
- Fresnel integrals 52, 58
- Fresnel reflection coefficient 47, 80, 264, 265
- Fresnel region 62
- Fresnel zone 54, 55, 106, 111, 113, 122, 126, 135, 174, 177, 260, 264, 292, 298, 333, 334, 350, 397
- Friis transmission formula 72, 97
- FSL, Free Space Loss 97

- gaseous absorption 146, 285
- Gaussian distribution 149, 226, 302, 338, 369, 402, 463
- GEO 332, 357
- GEO, Geostationary Earth Orbit ****

- geodesic 105
geographical information systems (GIS) 183
geometrical optics 47, 49, 50, 54, 56, 57, 64, 289
geostationary 7, 139, 160, 332, 357, 374
ghosting 244
GHz, gigahertz 4, 82, 113, 158
Giovanelli method 117–119, 126
GPRS, General Packet Radio Service 6
GPS, Global Positioning System 159, 376
grade of service 13, 14
grating lobes 447, 449
grazing incidence 43, 45, 118, 119, 121, 129, 174, 264, 277, 294
great circle 105, 106, 129, 135, 175, 180, 241
GSM 9, 15, 238, 249, 253, 422, 470
GSM, Global System for Mobile Communications (Groupe Spéciale Mobile) 6
GTD, Geometrical Theory of Diffraction 55
gyroscope 486
- handoff 13
handover 13, 18, 201, 430, 471
helical antenna 83, 84, 366
Hermitian 445, 456
Hertzian dipole 64, 66, 67, 73–76, 83, 465
hills 3, 5, 7, 54, 187
HLR 9
HLR, Home Location Register 9
homogeneous 37, 251, 294
horizontally polarised 32, 43, 369, 399
horn antenna 82, 83, 160
HPBW, Half-Power Beam Width 66, 76
Huygen's principle 50, 51
hydrometeor 140, 146
hysteresis 13
- Ibrahim and Parsons model 171
IEEE, Institute of Electrical and Electronics Engineers ****
IET, Institution of Engineering and Technology 468
IF, Intermediate Frequency 94, 96
Ikegami model 173, 174, 178–181
image theory 79, 80, 99
incremental metric 424–426
infinitesimal dipole 64, 65
input delay spread function 246, 252, 253
input impedance 68, 71, 77, 361, 365
insulator 30, 31
intelligent antennas 499
interleaving 236, 402, 413
intermediate frequency 94
intersymbol interference 244
ionisation 156
ionosphere 70, 155, 156, 158–160
ionospheric scintillation 153, 160
I-QHA, Intelligent Quadrifilar Helix Antenna ****
Iridium 332
irreducible error rate 245
IS95, Interim Standard -95 (US CDMA narrowband standard, now known as cdmaOne) 6
ISI 244, 245, 247, 249, 415–418, 423, 424, 426, 432, 433
ISM, Industrial, Scientific and Medical 385
isotropic 65, 67, 68, 77, 89–91, 93, 97, 102, 164, 292, 369, 437
ITU, International Telecommunications Union (an agency of the United Nations) 108, 109
ITU-R, International Telecommunications Union - Radio communications Bureau 149, 181, 182
- JTACS, Japanese Total Access Communication System 6
- k - factor 256, 461
Kalman filter 422
kHz, kilohertz 4
km, kilometre(s) 8, 97, 105
knife-edge 51–55, 57, 59, 113–115, 121–123, 126–128, 131, 172, 174, 179, 180, 274, 333, 334, 351
- LAN, Local Area Network 320
latitude 144
learning curves 421, 422
Lee model 169, 260, 261
LEO, Low Earth Orbit 332
LHCP, Left Hand Circular Polarisation 32, 151
linear array 77–79, 445, 446
linear equalisers 416, 422
linearly polarised 30, 32, 33, 41, 158
link budget 89, 101–103, 135, 189, 231, 318, 321, 323–326, 368, 461, 466
LMS 418–422, 426, 445
LMS algorithm 421, 422
LMS, Least-Mean Square 418
LNA, Low Noise Amplifier 95
local mean 164, 187, 333, 392, 473, 474, 477, 478, 486, 487
local median 89, 189
location variability 189–192, 195, 196, 199, 200, 277, 297, 300, 317–319, 472, 487
Loo model 339, 340
loop antenna 83

- LOS 89, 215, 221, 222, 261, 263, 268, 278,
341, 344, 461, 491
- LOS, Line Of Sight 215
- lossless 27, 28, 30, 37, 41, 77
- low earth orbit (LEO) 7, 332
- Lutz model 341–346, 349, 350, 355
- macrocells 8, 21, 163, 172, 175, 182, 183, 189, 196,
249, 250, 257, 277, 278, 293, 294, 300, 309, 376,
380, 382, 397, 497, 499
- magnetic field 25–27, 30, 31, 41, 42, 64, 83, 84, 99,
139, 156–158, 373
- MAHO, Mobile Assisted HandOver 13
- main edge 116, 117
- main lobe 66, 82, 396, 441, 447
- MAN, Metropolitan Area Network 430
- Manhattan grid 270, 272
- MAPL, Maximum Acceptable Path Loss 101
- maximum acceptable path loss 90, 91, 101, 113,
165, 166, 190–192
- maximum likelihood 423–425, 434, 459
- maximum ratio combining 407, 408, 429
- Maxwell's equations 25–27, 37, 39, 57, 62, 64, 305,
373, 497
- mean delay 247, 248
- mean effective gain 231, 368, 371, 484
- MEG, Mean Effective Gain 368, 369, 484
- megacells 21, 331, 348
- melting layer 143
- MEO 332
- MEO, Medium Earth Orbit 332
- meteorological 7, 111, 497
- metric 424, 425
- MHz, Megahertz 97
- microcells 8, 21, 181, 257, 259, 260, 264–266, 270–
272, 275–278, 284, 290, 293, 294, 309, 399, 461,
497, 499
- microstrip 84, 367, 384, 385
- microstrip patches 384
- microwave link 113, 409
- midamble 420
- Mie scattering 142, 244
- MIMO, Multiple Input Multiple Output 437
- MISO, Multiple Input Single Output 465
- ML 423, 426
- ML, Maximum Likelihood 423
- MLSE, Maximum Likelihood Sequence Estima-
tor 424
- mobile antennas 80, 362, 399
- mobile satellite 2, 140, 202, 249, 253, 332, 333, 336,
338, 342–344, 348, 353, 354, 356, 374, 498
- mobility 8
- monopole 80, 83, 131, 276, 364–366, 375, 376,
492
- MRC 430, 445, 466
- MS, Mobile Station 9
- MSC 9
- MSC, Mobile Switching Centre 9
- multipath 3, 19, 111, 112, 135, 195, 214, 215, 221,
222, 225, 229, 239, 241, 249, 253, 254, 265, 278,
289, 297, 300, 301, 309, 310, 332, 334, 335, 338–
341, 350, 354, 361, 381, 385, 391, 393, 403, 409–
411, 413, 429, 430, 434, 442, 443, 450, 460, 461,
465, 480
- multipath propagation 135, 214, 215, 229, 239, 278,
289, 335, 409, 461
- multiple access 17–19, 413, 427, 435, 441, 442
- multiple edge diffraction 121, 122
- multiplicative noise 3
- narrowband 4, 21, 22, 209, 210, 213, 214, 238,
241–249, 254, 277, 302, 333, 336–339, 342, 354,
357, 381, 391, 393, 413, 415, 427, 428, 430, 434,
450, 454, 461, 470, 478–481, 486
- NLOS 215, 216, 218, 225, 263, 271, 275, 341, 343,
344, 491
- NLOS, Non Line Of Sight 215
- NMT, Nordic Mobile Telephone 6
- noise enhancement 417, 418
- noise figure 94, 96, 103, 312, 374
- noise temperature 94, 95, 153–155
- Normal (Gaussian) distribution 149, 226, 302, 463
- NTT, Nippon Telegraph and Telephone Corpora-
tion 6
- Nyquist rate 449
- obstruction loss 54, 111, 113–115, 161, 164, 183
- odometry 486, 490
- Odyssey 332
- OFDM 22, 254, 413, 430–433, 435
- OFDM, Orthogonal Frequency Division
Multiplexing 254
- OFDMA, Orthogonal Frequency Division Multiple
Access 17
- omnidirectional 13, 67, 74, 76, 77, 83, 250,
322–324, 369, 374, 376, 377, 382, 385, 488
- optical limit 142
- optimum combining 443, 449
- orthogonal 17, 32, 68, 72, 153, 254, 381, 427,
430–433, 455, 464
- orthogonal frequency division multiplexing 254
- OS, Ordnance Survey 105

- outage probability 200, 204
 oxygen 146, 147

 p.d.f. 216–218, 221–223, 230–233, 340–342, 349, 394, 396, 399, 451
 parabolic equation 129, 131–133
 parabolic reflector 81, 160, 161, 385
 parasitic elements 78
 partially polarised 34
 patch antennas 84, 85, 368, 376, 380
 path diversity 19, 335, 426, 427, 430, 435
 path loss exponent 177
 path profile 105–107, 111, 126, 129, 131, 135, 163, 175, 187, 197, 198, 201
 pdf, probability density function 187, 189, 215, 349
 PDP, Power Delay Profile 246
 PE, Parabolic Equation 132
 PEL, Plane Earth Loss 100, 101
 penetration loss 285, 294–297, 309, 319
 permeability 25, 29, 38
 permittivities 37, 306
 permittivity 26, 29, 38, 268, 298, 299, 352
 phase velocity 28, 30, 31, 38, 39, 41, 59, 108
 phased array 437, 438
 PHS, Personal Handyphone System 6
 physical models 172, 183, 261, 262, 274, 278, 283, 288, 289, 291, 299, 309, 345–347, 498
 picocells 8, 21, 283, 289, 291, 294, 309, 321, 384, 399, 499
 PIFA, Planar Inverted-F Antenna 367
 pilot symbols 426, 434
 PIM, Passive InterModulation 380
 planar array 77
 plane earth loss 98, 100, 101, 164, 165, 167, 170, 172, 173, 191, 264, 303
 plane of diffraction 56
 plane wave 26, 28, 30, 32–34, 37, 38, 41, 47, 49–51, 57, 64, 65, 72, 142, 160, 445, 449
 plasma 155, 156
 point of incidence 37, 40
 polarisation 32–34, 39, 40, 42–44, 57, 58, 64, 72, 73, 84, 85, 129, 132, 134, 143, 151–153, 156–159, 167, 264, 265, 372, 375, 376, 381, 384, 397, 399–402, 461, 463–465, 498
 polarisation diversity 381, 399–402, 464
 polarisation mismatch loss 72, 384
 population density
 power density 28, 65, 71, 370, 374, 384
 power gain 68, 70
 power law model 164, 169, 200
 Poynting vector 26, 28, 31, 34, 37, 64, 65

 preamble 420
 prediction tools 169
 prime focus 160, 161
 probability density function 187–189, 215, 216, 226, 348, 349
 propagation mechanisms 37, 48, 49, 59, 89, 135, 161, 181, 257, 270, 271, 284, 288, 290, 297, 302, 469
 propagation vector 26, 32, 37
 PSTN 9
 PSTN, Public Switched Telephone Network 9

 Q, Quality factor 362
 QAM, Quadrature Amplitude Modulation 19
 QHA, Quadrifilar Helix Antenna 375
 QPSK, Quaternary Phase Shift Keying 19
 quadrature 19, 215, 238, 376, 473, 480
 quadrifilar helix antenna 375
 quality 8, 10, 12, 13, 19–21, 90, 102, 200, 227, 239, 309, 310, 362, 391, 411, 413, 435, 440, 466, 471, 499

 radiation intensity 65, 66, 68
 radiation resistance 67, 68, 77, 80, 307, 362
 rain 7, 140–146, 149, 151–155, 268, 357
 rain attenuation 141, 143–145, 153, 357
 rain cells 144
 rainfall rate 142–145
 Rake receivers 22, 413, 427, 430, 435
 random polarisation 33, 43
 random processes 236
 Rayleigh approximation 142
 Rayleigh channels 218, 221, 408, 457
 Rayleigh criterion 46, 47
 Rayleigh distribution 215, 217, 218, 221, 225, 226, 338, 340, 342, 349, 474
 Rayleigh fading 112, 220, 228, 236, 303, 430, 449, 462, 474, 476, 483
 receiver sensitivity 90, 472
 reciprocity 70–72, 91, 437
 reciprocity theorem 70–72, 91
 recursive least squares 422
 reflection coefficient 39, 43, 44, 47, 68, 80, 100, 129, 242, 264, 265, 269, 289, 292, 334
 reflector 78–81, 160, 380
 reflector antennas 79, 81, 160
 refraction 3, 37–41, 49, 59, 73, 108, 148, 156, 160, 305
 refractive index 39, 108, 109, 111, 112, 131, 132, 148, 156, 158, 410
 reuse distance 11, 12, 200, 440

- RF, Radio Frequency 13
RH, Right Hand ****
RHCP, Right Hand Circular Polarisation 32
Rice (Rician) distribution 226
Rice factor 222, 239, 341
RLS 422, 426, 445
RLS, Recursive Least Square 422
RMS delay spread 247–251, 254, 277, 278,
300–303, 314, 354, 384, 462
RMS, Root Mean Square ****
roadside trees 336, 339
rooftop diffraction 174, 180, 183, 271
rough surface 3, 45
roughness 45–48, 129, 244, 306, 307
rural 8, 10, 249, 339, 341, 346, 369, 453, 466,
488

SAR, Specific Absorption Rate 370, 372
satellite fixed links 7, 21, 139, 148, 161, 426
satellite process 356
scattering 3, 37, 39, 45, 57, 59, 90, 106, 129,
140–142, 171, 180, 202, 241, 242, 244, 246, 251,
257, 264, 270, 272, 277, 301, 334, 348, 354, 368,
397–399, 411, 441–443, 451, 452, 460, 462, 463,
466, 498
scattering map 451, 452, 498
scattering plane 37, 39
scintillation 148–153, 160, 357
SDMA, Space Division Multiple Access 17, 441
sector antenna 378
sectorisation 12, 13, 201, 204, 272, 314, 376, 385,
441
selection combining 403–405, 409
serial correlation 197, 202, 477
settled field 177, 179, 180
SFIR 440, 441, 449
SFIR, Spatial Filtering for Interference Reduc-
tion 440
shadow region 50–52, 57, 59, 270
shadowing 3, 4, 8, 13, 21, 187–192, 195–205, 209,
210, 221, 227, 250, 277, 286, 288, 297, 300, 303,
310, 319, 332–336, 338, 339, 341–350, 354–357,
366, 375, 410, 439, 461–464, 472, 473, 477, 478,
486, 488
side lobes 66, 82
SIMO, Single Input Multiple Output 465
SINR, Signal to Interference plus Noise Ratio 440
SIR, Signal to Interference Ratio
skin depth 29, 294
slow fading 3, 187
SM, Spatial Multiplexing 465, 466

SMS, Short Message Service 6
Snell's law of reflection 37, 41, 80
Snell's law of refraction 38–41, 108
SNR, Signal to Noise Ratio 93, 211
solar wind 156
space diversity 112, 393–400, 410
space division multiple access (SDMA) 17, 441,
442
spatial filtering for interference reduction 440
specific attenuation 134, 135, 141, 142, 147, 294
spectral efficiency 10, 19
specular 45, 47, 173
spherical wave(s) 47, 50, 51, 63, 292
spread spectrum 18, 354, 427
spreading factor 50, 56, 58, 123, 292
SRLS, Square-root Recursive Least Square 422
standard deviation 47, 126, 131, 149, 189, 198, 211,
215, 217, 278, 287, 340, 341, 348, 369, 370, 384,
469, 471, 472, 474, 476
station keeping 139
statistical models 270, 337, 345, 347, 348, 350, 498
STC, Space-Time Coding 441
STEC, Slant Total Electron Content
steering vector 445–447, 449, 451
step size parameter 421
street canyon 265–268, 277, 278, 463
STTD, Space Time Transmit Diversity 465
subreflector 160
subrefractive 112
suburban 7, 8, 165, 167, 168, 171, 189, 195, 196,
263, 333, 334, 341, 344, 347, 350, 352, 452, 462,
488
superrefractive 111
switched combining 405, 409

TACS, Total Access Communication System 6
TDD, Time Division Duplex 17
TDMA, Time Division Multiple Access 17
TEC, Total Electron Content 158
temperature inversion 112
terrestrial fixed links 6, 7, 21, 105, 409
terrestrial process 356
TETRA 238
time diversity 310, 402, 403
time share of shadowing 342
time slots 10, 18, 411
total excess delay 247, 248, 254
traffic density 8, 13
traffic prediction
training sequence 419, 420, 481
transition region 57, 58, 61, 122

- transmission line 61, 68, 73, 74, 77, 78, 297, 298,
 315, 364, 367, 386, 483
 transmit diversity 410, 411, 438, 456, 466
 trellis diagram 424, 425
 troposphere 108, 140, 148, 149, 151, 160
 tropospheric refraction 108, 148
 tropospheric scintillation 148, 149, 152
 trunking 13, 313
 turbo codes, coding 20
 TVT, Time-Variant Transfer function 251
- ULA, Uniform Linear Array 445
 UMTS 249, 250
 undersampling 447
 uniform linear array (ULA) 77–79, 445, 446
 uniformity of coverage 384
 uplink 17, 18, 102, 311, 313, 320, 321, 325, 438,
 440, 450, 466
 urban 7, 8, 10, 165, 167, 168, 170, 172, 173, 195,
 196, 249, 250, 259, 276, 278, 341, 344, 346, 352,
 462, 463, 466
 USDC, United States Digital Cellular (IS54) 6
 USGS, United States Geographical survey 106
 UTD, Uniform geometrical Theory of Diffraction 57, 122
 UWB, Ultra Wideband 302, 364
- variance 200, 211, 214, 222, 235, 239, 348, 445,
 457, 463, 474, 475
 V-BLAST, Vertical Bell Labs Space Time 460
 vector 25–28, 31, 32, 34, 37, 64, 65, 72, 73, 157,
 371, 419, 443–447, 449, 451, 453, 489, 497
 vertical distribution 311
 vertical polarisation 129, 132, 134
 vertical space diversity 112, 396, 410
- vertically polarised 32, 43, 368, 396, 399
 visible region 59
 Viterbi algorithm 425, 426
 Viterbi equalisation 424–427
 VLR 9
 VLR, Visitor Location Register 9
 Vogler method 117, 122, 126
 voltage standing wave ratio (VSWR) 68
 VSWR, Voltage Standing Wave Ratio 68
 VTEC, Vertical Total Electron Content 158
- water vapour 108, 147–149
 wave impedance 27, 30, 31, 39, 41, 64, 92,
 268, 297
 wavefront 26
 waveguide 61, 82, 97, 268, 269, 305–309, 367
 wavenumber 27
 WCDMA, Wideband CDMA 6
 wideband channel model 245, 249, 354
 Wiener solution 418, 419, 444, 445, 447, 448
 Wi-Fi, Wireless Fidelity. 257, 287, 462
 WiMax, Worldwide Interoperability for Microwave
 Access (IEEE 802.16) ****
 wireless channel 2, 3, 6, 22, 59, 497
 WLAN, Wireless LAN ****
 WSSUS 251
 WSSUS, Wide-Sense Stationary Uncorrelated Scat-
 tering ****
- XPD, Cross Polar Discrimination ****
 XPI, Cross Polar Isolation ****
- Yagi 78, 79, 84, 364, 381–383, 385
- zenith 147, 148, 156, 158, 159, 332, 375