

Index

- 3D cellular network, 159, 161
- 3D deployment, 161
- 3D wireless network, 159, 168
- 3GPP
 - Release 15, 209, 231
 - Release 16, 232
- 3GPP standardization, 208, 227
- 3GPP standards, 209
- 4G, 212
- 5G, 15, 208, 234, 237
- 5G new radio, 207, 208, 234
- 6G, 207
- Aerial wireless channels, 27, 37, 40, 51, 56, 67
 - characteristics, 27
 - height, 28
- Air traffic management, 209
- Airframe shadowing, 28, 43
- Angel of arrival, 35
- Angel of departure, 35
- Angular spread, 57
- Antenna array, 15, 181, 192–195, 198, 203
- Antenna configuration, 29
- Antenna tilt, 216
- Artificial intelligence, 238
- Backhaul, 18, 159, 169
- Bang-bang solution, 201
- Beamforming, 15, 115, 116, 181, 192, 193
- Caching, 112–114, 116, 117, 120, 169, 174, 175, 183, 189, 191
- Cauchy-Schwarz inequality, 186
- Cell association, 101, 103, 117, 126, 133, 134, 145, 146, 149, 152, 159, 161, 165
- Cellular technologies, 208
- Channel modeling, 36, 40, 229
 - weather effects, 50
- Circle packing, 93, 97, 122
- Cloud radio access network, 112, 118
- Coherence time, 52
- CoMP, 183, 185, 189, 191, 205
- Complex baseband signal, 60
- Continuous phase modulation, 65
- Control time, 193–195, 198–200, 202
- Cooperation, 181
- Cooperative communications, 181, 191
- Coordinated multi-point transmission, 181, 218
- Coverage probability, 73, 74, 78, 79, 83, 86, 96, 97, 181, 186, 187, 189, 191
- Covering problem, 93
- D2D, 70, 71, 77, 82, 84
- Data acquisition, 233
- Deep echo state network, 131, 132, 134
- Deep reinforcement learning, 131, 134
- Delay spread, 54
- Device-to-device communication, 13, 70, 209
- Diffraction, 35, 40, 42, 46
- Direct sequence spread spectrum, 22, 64
 - Rake receiver, 65
 - spreading waveform, 64
- Disk covering problem, 79
- Doppler effects, 53
- Doppler shift, 25, 26, 29, 63
- Doppler spread, 29, 52
- Down-tilt, 184
- Duty cycle, 170
- Echo state networks, 116, 131
- Empirical path loss model, 40
- Excess path loss model, 42
- Facility location, 91, 92
- Fading, 27, 35, 52, 188
- Flight time, 68, 81, 146
- Floating intercept model, 39
- Flying mode detection, 231
- Flying taxi, 21
- Frequency division duplex, 211
- Frequency hopping spread spectrum, 64
- Frequency planning, 162, 163
- Frequency reuse factor, 163
- Frequency selectivity, 54

- Fresnel zone, 45
- Fronthaul, 113, 117, 118, 169, 173
- Game theory, 123, 128, 244
 - behavioral strategy, 130
 - dynamic noncooperative game, 128
 - Nash equilibrium, 130, 249
 - subgame perfect Nash equilibrium, 130, 132, 135
- General ray tracing, 35
- Global navigation satellite system, 210
- GPRS, 212
- GPS spoofing, 240, 242
- Handover, 221, 230
- Handover failure, 220, 222
- High-altitude platforms, 3, 6, 10, 18, 44, 159
- Hover time, 145, 148, 150, 155
- Information dissemination, 13
- Interference, 8, 70, 73, 82, 99, 109, 113, 123, 126, 136, 181, 183, 185, 218
- Interference detection, 229, 232
- Interference mitigation, 230
- Internet of Things, 16, 90, 100, 101, 107, 108, 111
- Jain fairness index, 154
- Large-scale propagation effects, 24, 30
- Latency, 68, 81, 125, 138, 141, 160, 167, 223
- Licensed band, 169, 172, 174
- Licensed-assisted access, 226
- Line-of-sight probability, 44, 47, 50, 73, 85, 97, 102, 148
- Line-of-sight propagation, 23, 28, 45
- Location-based services, 209
- Log-distance path loss, 37
 - basic model, 37
 - dual-slope, 40
 - modified model, 39
 - multi-slope, 40
- Loon, 3
- Low altitude platforms, 3, 6, 159
- LTE, 207, 209, 210, 216
 - evolved packet core, 212
 - introduction, 210
 - radio access network, 212
 - radio interface, 213
 - RAN protocol stack, 213
 - system architecture, 212
- LTE-U, 169, 171, 226
- Machine intelligence, 238
- Machine learning, 90, 112, 116, 128, 160, 175, 179
 - k-mean clustering, 117
 - liquid state machines, 175
 - recurrent neural networks, 112, 116, 131
 - spiking neural networks, 175
- Millimeter wave, 14
- Mobile broadband, 207
- Mobility management, 9, 220
- Mobility models, 223
- Multi-antenna techniques, 211
- Multipath, 26, 29, 35, 51
- Multiple access, 81, 146
- Nakagami fading, 59, 185
- Network interdiction game, 246
- Network slicing, 237
- OFDM, 211, 215, 235
 - cyclic prefix, 215
- Optimal control, 195, 200, 201
- Optimal transport theory, 151, 165
 - Monge-Kantorovich problem, 152
- Orthogonal frequency division multiplexing, 62
 - cyclic prefix, 63
 - waveform, 63
- Outage probability, 82, 87
- Path loss, 25, 30, 31, 33, 34, 37, 39, 40
- Path loss exponent, 37, 38
- Path planning, 123, 124, 128, 134
- Performance analysis, 68, 72, 80
- Perturbation technique, 196
- Power control, 103–105, 126, 131, 232
- Propagation modeling, 7, 22, 23, 27, 36
- Prospect theory, 244
 - framing, 251
 - rationality parameter, 252
 - weighting effect, 251
- Public safety, 12, 13
- Q-learning, 176
- Quadrator, 193, 199
- Radio wave propagation
 - absorption, 24
 - diffraction, 23
 - fundamentals, 23
 - reflection, 23
 - refraction, 23
 - scattering, 24
- Ray tracing, 24, 31, 47
- Reflection, 40
- Reinforcement learning, 123, 131, 134
- Reliability, 107, 109, 224, 225
- Remote radio heads, 112, 115
- Reservoir computing, 131
- Resource management, 7, 145, 159, 169, 174, 180
- Resource planning, 159
- Rician channel model, 58, 125

Scattering, 35, 40, 47	wireless networking scenarios, 12
Security strategy, 248	UAV base station, 6, 12, 14–16, 18, 68, 70, 73, 79, 97–101, 104, 145, 147, 149, 159, 166, 170, 181, 192, 203, 208, 226
Shadowing, 30, 42	challenges, 7
Small-scale propagation effects, 25, 51	UAV BS, 94
Smart city, 20	UAV relays, 9, 14, 18, 227
Spatial selectivity, 56	research challenges, 10
Spectrum allocation, 174, 175	UAV security
Spectrum management, 145, 169	communication channel attacks, 240
Stochastic geometry, 68, 181	delivery systems, 243
binomial point process, 184	denial-of-service attacks, 241
Poisson point process, 69, 183	eavesdropping, 241
Stop points, 80, 83	false data injection, 241
Thrust, 199	fly-away attack, 241
Time division duplex, 211	GPS attack, 240
Time selectivity, 52	GPS attacks, 241
Trajectory optimization, 123	information attacks, 241
Truncated octahedron, 161	man-in-the-middle attack, 241
Two-ray model, 31, 33, 34, 37	physical attacks, 244
height dependent, 41	UAV user equipment, 8, 13, 18, 19, 41, 123, 124, 128, 134, 159, 166, 181, 183, 184, 188, 208, 216, 224, 228, 229
UAV, 1	identification, 9
applications, 12	research challenges, 8
classification, 3	Unlicensed band, 169, 174
command and control, 223, 237	
definition, 1	
deployment, 90, 100, 105, 116, 117, 161	
history, 1	
identification, 209, 230–232	Virtual reality, 18
interference, 217	Virtual reality, ECHOTL, MING01, 16
localization, 210	Virtual reality, MING01, 237
mission time, 124	Voronoi diagram, 149, 153, 166
mobility, 9, 79, 106, 125, 220, 230	
positioning, 210	Waveform, 22
regulation criteria, 5	Waveform design, 22, 60
regulations, 4	Wind dynamics, 195, 199
security, 240	Wireless research challenges, 6
trajectory, 123	
wireless communications and networking, 5	Zephyr, 3