

Subject Index

- ACC, *see* Adaptive Cruise Control
 - evaluation
 - communication failure, 216
 - controller, 217
 - sensor robustness, 216
- ADA, *see* Advanced Driver Assistance
 - cooperative
 - ACC controller, 224
 - safety margin, 177
 - SUMMITS, 208
 - reliable, 70
 - repetitive, 69
- Balise, *see also* European Train Control System, 84
- CDN, *see* Content Distribution Network, 265
- Collision avoidance
 - Adaptive Cruise Control, 217, 218
 - cooperative, 119, 150
 - Positive Train Control, 135
- Communication
 - application
 - voice communication, 33
 - public safety
 - failure, 33
 - first responder, 30
 - GPS, 31
 - history, 30–31
 - inter-agency, 33
 - 9/11, 31, 33
 - Wi-Fi locator, 31
 - traffic class
 - WiMAX, 184
- Communication protocol
 - anonymous gossip, 70
 - Application Sub Layer, 162
 - ARIB STD-T88, 162
 - automotive message set, 159, 168
 - broadcast, 17, 18, 66, 85, 88, 158, 180, 220
 - coexistence, 266
 - compliance, 107
 - CSMA, 66, 240
 - DHCP, 76
 - FTP, 163
 - geocast, 12, 15, 17, 18, 20, 78
 - geographical addressing, 185
 - HTTP, 163
 - IEEE 1609.0, 159
 - IEEE 1609.1, 158, 174
 - IEEE 1609.2, 106, 109, 159, 174
 - IEEE 1609.3, 159, 174
 - IEEE 1609.4, 62, 65, 159, 174
 - IEEE 1609.5, 159
 - IEEE 802.11p, 240
 - IEEE 802.11
 - SyncScan, 237
 - ACK, 233
 - basic access procedure, 233
 - DeuceScan, 238
 - DIFS, 233
 - fast handover support, 228, 231–238, 240
 - OpportunisticScanning, 238
 - Post Transmission Backoff, *see* PTB
 - PTB, 233
 - TBTT, 233, 237
 - TSF, 232
 - IEEE 802.11n, 178
- IGMP, 194
- IP, 18, 155, 163, 266
- IPv6, 175, 186–187
 - 6lowpan, 197
 - uIPv6, 197
- ISA-SP100.11a, 196
- MANET, 65, 76
- MEXT, 176

- MLD, 194
- Mobile IP
 - inter-agent handover, 196
- Mobile IPv4, 175
- Mobile IPv6, 176, 186–194
 - multiple access networks, 190
 - network mobility, 187
- multicast, 85, 90, 194, 238
 - acknowledged, 87, 181
 - anonymous gossip, 71
- NEMO, 76, 175, 176, 187–190
 - Binding Update, 188
 - flow identification, 190
 - HA proxy, 193
 - handover delay, 194
 - multiple flow handover, 191
 - RO security issues, 193
 - RO solution space, 193
 - Route Optimization, 191–194
- PIM-SM, 194
- position-based, 111, 113, 186
 - routing, 78
- routing
 - geographical, 185
 - IP multicast, 194–196
 - Route Optimization, 176
- RTCP, 88
- SAE J2735, 159, 168
- security, 231
 - IEEE 1609.2, 106, 109
- spanning tree, 32
- TCP, 12, 155, 163, 266
- UDP, 12, 155, 266
- unicast, 15, 17–19
- WAVE stack, 174
- Wireless HART, 196
- WSMP, 11, 12, 15, 16, 18, 64, 186
- Z-Wave, 196
- ZigBee, 196
- Communication system
 - ad hoc
 - MANEMO, 176
 - MANET, 71, 176
 - aggregated moving network, 176
 - automotive
 - ad hoc, 36, 161, 175, 178
 - antenna patterns, 47–48
 - ARIB STD-T75, 162
 - DSRC, *see* Dedicated Short Range Communications, 2, 4, 5, 7, 26, 37, 46, 61, 66–69, 75, 157, 158, 160–162, 172, 173, 175, 181
 - IEEE 802.11p, 95, 158, 173, 178–181, 235
 - multichannel MAC, 61–66
 - propagation model, 48–50
 - autonomicity and evolvability, 259, 266
 - availability, 108
 - basic security, 111–112
 - coexistence, 258
 - cognitive, 253, 259, 266
 - collaboration and cooperation, 267
 - coordination, 267
 - distributed, 267
 - dynamical coordination, 253
 - convergence, *see also* integration, interoperability, 259
 - data centric, 115
 - equipment certification, 41
 - fast handover architecture, 240–241
 - macro cell, 240
 - micro cell, 240
 - overlay MAC, 240, 250
 - RCU, *see* RCU
 - RCU, 240–243
 - Remote Base Station, *see* RBS, *see* RBS
 - RBS, 240–243, 250
 - future system, 253
 - GSM-R
 - CAB Radio, 173
 - handover delay, 184, 237
 - APTT metric, 245
 - challenges, 239
 - DeuceScan, 238
 - IEEE 802.11, 231–238
 - influence of data rate, 233–235
 - mobile WiMAX, 185
 - OpportunisticScanning, 238
 - SyncScan, 237
 - handover requirements, 229–230, 239
 - handover taxonomy, 228, 230–231
 - handover criteria, 230–231
 - handover decision, 230–231
 - higher layer aspects, 230
 - link layer reestablishment, 230–231
 - network discovery, 230–231
 - HSDPA
 - hard handover, 98
 - IEEE 802.15.1, 196
 - IEEE 802.15.4, 196

- implementation, 228, 239
 - automated toolchain, 243–244
 - C-code, 243–244
 - intra-macro-cell handover, 242–243
 - intra-micro-cell handover, 242
 - key postulates, 239
 - MAC scheme, 241–242
 - methodology, 243–244
 - performance evaluation, 245–252
 - predictive fast handover, 242–243
 - proof-of-concept demonstrator, 244–245
 - RBS, 244
 - SDL, 243–244
 - system architecture, 240–241
- integration, *see also* interoperability, 38, 101–102, 125, 261
- interoperability, *see also* integration, 35–37, 151–152, 175
 - protocols, 163
 - standardization, 151–152
- MAC
 - centralized, 240
 - deterministic, 229, 240
 - hybrid, 229
 - SDU, 231
 - stochastic, 229, 240
 - synchronization, 231, 232
- mesh network, 238, 253
 - IEEE 802.11s, 36
 - public safety, 32, 253
- mobile AP
 - public safety, 31
- mobile router
 - Mobile IPv4, 175
 - NEMO, 187, 190
 - public safety, 32
- multi-radio, 36, 177, 190
 - multichannel coordination, 61
 - multiple control channels, 66
 - single control channel, 65
- on-board
 - CAN, *see* Controller Area Network, 150, 155, 163, 196
 - Ethernet, 100
 - gateway, 101
 - IPTrain, 100
 - MVB, *see* Multifunction Vehicle Bus, 99
 - Profinet, 100
 - TCN, *see* Train Communication Network, 99–100
 - TORNAD, 84
 - TGV, 84
 - WTB, *see* Wire Train Bus, 100
- PHY
 - synchronization, 231
- public safety
 - ad hoc, 35
 - Extended Area Network, 38–40
 - group communication, 34
 - IEEE 802.11p, 39
 - Incident Area Network, 35–36
 - Jurisdictional Area Network, 36–38
 - packet data, 30
 - permanent infrastructure, 36
 - push to talk, 31
 - quick kits, 36
 - regional network integration, 39
 - trunking, 31, 34
 - vehicular relay, 31
- railway
 - Airlink, 102
 - EIRENE, 97
 - GSM-R, 85, 96, 258
 - hard real time, 99
 - IAGO, 102
 - integration, 101–102
 - magnetic coupling technology, 93
 - MODCOMM, 102
 - on-board, 99–100
 - propagation model, 92
 - regulation, 93
 - satellite, 99
 - services, 88–91
 - soft real time, 100
 - train motion influence, 93
 - wireless link model, 92–93
 - wireless systems, 93–99
- requirements
 - access delay, 229
 - delay, 231
 - Inter-Arrival Time, 229, 249
 - jitter, 229
 - location information, 229
 - packet loss, 231
 - packet reordering, 231
 - radio cell overlap, 237, 242
 - RSSI, 231, 237, 247
 - railway, 85–88, 229–230
 - Round Trip Time, 229

- RFID, 175
- safety
 - beacon, 112
- satellite, 99
 - IRIDIUM, 30
 - Teledesic, 30
- security
 - necessity, 122
- security architecture, 106, 109–111, 116, 124
- service interruption time, *see* handover delay
- Software Defined Radio, 153
- train to wayside
 - evolution, 83–84
- vehicular
 - IEEE 802.11, 228, 232, 240, 253
- wearable, 42
- WiBree, 196
- wireless
 - 3GPP LTE, 173, 181–184
 - break-before-make handover, *see* hard handover
 - hard handover
 - BSS association, 180
 - cost, 231
 - EDGE, 97
 - GPRS, 97, 176, 181, 258
 - GSM, 96, 181
 - handover, 230, 239
 - handover frequency, 230
 - handover phases, *see* handover taxonomy
 - hard handover, 183, 231
 - HSDPA, 98, 182
 - HSUPA, 98
 - LMR, *see* Land Mobile Radio, 36, 38
 - make-before-break handover, *see* soft handover
 - mobile WiMAX, 185
 - soft handover, 231
 - support for high user velocities, 230
 - UMTS, 98, 181
 - vertical handover, 183
 - virtual beacon, 181
 - Wi-Fi, 94, 155, 181
 - wide-area automotive, 181–185
 - WiMAX, 36, 38, 95, 173, 184–185
- Cooperation
 - awareness, 119
 - cognitive, 267
 - collision avoidance, 119
 - V2I system
 - performance criteria, 205
 - vehicle-driver, 204
 - vehicle-infrastructure, 204
 - vehicle-infrastructure system
 - design problems, 204–205
 - human factors, 205
 - human factors, 203, 204, 206, 208, 225
 - traffic flow, 203, 204, 206
 - vehicle-vehicle, 209
- CR, *see* Cognitive Radio, 267
- Credential certification
 - Certification Authorities
 - cooperation, 117
 - Certification Authority, 106, 109, 116, 154
 - multi-domain, 117
 - organizational concerns, 124
 - Pseudonym Provider, 111
 - regional, 109
 - revocation, 117
 - self-certification, 113
- DOT, *see* United States Department of Defense
 - Strategic Rail Corridor Network, 130
- DOT, *see* United States Department of Transportation, 21
- ITS spectrum, 2
- STB, *see* Surface Transportation Board
 - interstate commerce act, 144
 - Transportation Technology Center, 137
- DTN, *see* Disruption- and Delay Tolerant Network, 265
- VANET, 265
- EAN, *see* Extended Area Network, 38–40
 - IEEE 802.16e, 38
 - integration, 38
 - LMR, 38
- Equipment certification
 - military, 41
- Future Internet
 - Internet of things, 265
 - Network symbiosis, 265
 - Smart objects, 265
 - VANET, 265
- IAN, *see* Incident Area Network, 35–36
 - IEEE 802.11s, 36
 - mesh network, 36, 238, 253

- temporary infrastructure, 35
- use cases, 35–36
- VANET, 35, 40
- IRSA, *see* Integrated Full-Range Speed
 - Assistant
 - controllers, 209–212
 - implementation, 219
 - scenarios, 209
- ITS modeller, 204
- JAN, *see* Jurisdictional Area Network, 36–38
 - IEEE 802.11, 36
 - IEEE 802.16e, 36
 - IEEE 802.22, 37
 - mesh network, 36, 238
 - permanent infrastructure, 36
- MARS, *see* Multi-Agent Real-time Simulator, 204
- Multi-Aspect Assessment
 - approach, 204
- NSA, *see* United States National Security Agency
 - information assurance technical framework, 139
- OSI, *see* Open Systems Interconnection, 89, 138, 149, 154, 162
- Performance evaluation
 - Access Point Transition Time, *see* APTT
 - APTT, 245
 - application
 - cryptographic overhead, 116
 - application reliability, 69
 - cooperative system, 205
 - empirical results, 249–252
 - Inter-Arrival Time, 249
 - emulation
 - vehicular mobility, 247
 - IEEE 1609.4, 63
 - IEEE 802.11p, 58–61, 235
 - hidden terminal, 180
 - MAC, 180
 - OFDM, 59
 - Packet Error Rate, 178
 - traffic density, 181
 - transmission range, 179
 - IEEE 802.11
 - Access Point Transition Time, *see* APTT
- APTT, 245
 - active scanning, 232–233
 - association, 232
 - authentication, 232
 - handover, 231–238
 - handover decision, 232, 237
 - joining a BSS, 232
 - link layer reestablishment, 232–235, 238, 253
 - network discovery, 232, 237–238
 - passive scanning, 232–233
- radio system
 - channel switch time, 245
- train communication
 - IEEE 802.16d, 95
- train control
 - performance management, 144
 - security cost, 142
 - security indicator, 145
- VANET
 - applications, 20
 - broadcast protocols, 69
 - broadcast reliability, 66
 - gossip protocol, 71
 - multichannel coordination, 64–65
 - NEMO, 76
 - packet drop burst, 67
 - packet drop rate, 67
 - packet loss, 64
- Positioning
 - ERTMS, 102
 - GNSS, 119
 - CALM, 175
 - Doppler shift, 121
 - forged signal, 119
 - GPS, *see* Global Positioning System
 - PTC, 134, 144
 - public safety, 31
 - VANET, 23
 - vehicular communication, 23, 151, 210, 214
- radar
 - vehicular communication, 215
- railway infrastructure, 229
 - signal indications, 132
 - track database, 144
- SCADA
 - Communications-Based Train Control, 229
 - PTC, 132, 229

- Wi-Fi locator
 - public safety, 31
 - Privacy
 - anonymity, 108
 - strong, 108
 - attack, 106
 - identity linking, 108
 - cost reduction, 115–116
 - enhancing technologies, 106, 113–116
 - identity
 - disclosure, 108, 109, 114
 - identity concealment, 108
 - position, 122, 229
 - pseudonym, 111, 113–117, 121–123
 - Baseline Pseudonymous
 - Authentication, 113
 - basic security, 111
 - Hybrid Pseudonymous
 - Authentication, 114, 122
 - lifetime, 115
 - short term identity, 117
 - Radio channel measurement
 - point of acquisition
 - local, 231
 - remote, 231
 - positional reference
 - differential GPS, 51
 - reference clock
 - Rubidium frequency standard, 51
 - signal waveform
 - analysis, 51
 - generation, 51
 - recording, 51
 - Radio propagation, *see* V2X radio channel
 - Radio system
 - antenna
 - directive, 47, 48, 77, 178
 - eigen-beamforming, 178, 183
 - MIMO, 182, 184
 - mismatch, 31
 - mount, 47, 49
 - multiplexing, 183
 - satellite, 99
 - size, 92
 - spatial multiplexing, 184
 - channel access
 - deterministic MAC, 229
 - FDD, 98, 162
 - hybrid MAC, 229
 - stochastic MAC, 229
 - TDD, 98, 184
 - TDMA, 37, 162
 - Channel State Information, 183
 - IEEE 802.11p, 178
 - baseband, 178
 - PHY layer, 179
 - interference mitigation, 182
 - mobility
 - performance impact, 182
 - modulation
 - BPSK, 158
 - CDMA, 31
 - cyclic prefix, 59
 - Doppler resistance, 179, 183
 - DSSS, 51, 56
 - OFDM, 51, 59, 95, 158, 179, 180, 182, 184
 - OFDM mid-amble, 180
 - pilot-carrier, 60–61
 - QPSK, 158
 - Scalable Adaptive Modulation, 37
 - SCFDMA, 95
 - sub-carrier, 59, 60, 179, 184
 - WCDMA, 98
 - multi-user diversity, 183
 - performance
 - channel switch time, 245
 - radio channel
 - equalization enhancements, 61
 - spatial multiplexing
 - 3GPP LTE, 182
 - WiMAX, 184
 - symbol period, 56
 - temporal diversity, 183
- Regulation
 - performance-based, 138
 - prescriptive-based, 138
 - spectrum
 - automotive, 2, 152
 - DTV transition, 36, 152
 - global harmonization, 164, 165
 - global variation, 163
 - public safety, 36
 - public safety channels, 37
 - railway, 93
 - TV bands, 36, 162, 174
 - WRC/RRC, 93, 167
 - Regulatory authority
 - FCC, 2, 10, 38, 93, 154, 158, 173
 - ITU-R, 46, 165
 - WRC/RRC, 93, 165

- SCADA, *see* Supervisory Control and Data Acquisition
- Communications-Based Train Control, 129, 229, 236, 239, 253
 - handover requirements, 229–230, 236, 239, 242, 253
 - Communications-Based Train Control, 228
 - Digital Control Systems, 129
 - Positive Train Control, 129, 132, 229
 - handover requirements, 229–230
 - wireless, 132
- SDR, *see* Software Defined Radio, 51, 153, 231, 266
- CR, 266
 - GPS adversary, 119
- Security
- attack
 - active, 140, 142
 - adversary, 107
 - branding, 118
 - close in, 140
 - collusive, 107
 - denial of service, 140
 - distributed, 142
 - distribution, 107, 140
 - external, 107
 - false information, 106
 - false position, 119
 - IATF classification, 139
 - identity linking, 114
 - identity theft, 140, 142
 - insider, 140
 - internal, 107
 - jamming, 140
 - mal-actor, 106, 107, 142
 - malicious association, 140
 - man in the middle, 140
 - message forge, 107
 - message inject, 107
 - message replay, 107
 - mitigation, 108, 141
 - passive, 139
 - passive adversary, 107
 - relay, 112
 - replay, 112
 - rogue protocol, 107
 - sensor adversary, 108
 - tracing, 108
 - vehicle tracking, 122
 - attack detection
 - distributed, 118
 - forged GNSS messages, 121
 - attribute
 - accountability, 142
 - authenticity, 108, 141
 - availability, 141
 - confidentiality, 108, 141
 - identification, 142
 - integrity, 108, 141
 - authentication
 - anonymous, 114
 - data origin, 142
 - Group Signature, 114
 - certification
 - certificate period, 115
 - domain, 109
 - Foreigner Certificate, 117
 - private key, 106, 107, 110–112, 114, 117, 118, 123
 - public key, 106, 110–112, 114, 116, 117, 121, 122
 - revocation, 116–118, 123
 - cost reduction, 115–116
 - cryptographic
 - authentication, 142
 - Hardware Security Module, 42, 110, 118
 - hash function, 143
 - module, 42
 - on-board processing cost, 123
 - overhead, 115, 116, 123
 - protection, 119
 - tools, 122–123
 - cryptographic overhead
 - system performance, 116
 - data centric, 106, 119
 - encryption, 89, 96
 - elliptic curve, 122
 - military, 41
 - key management, 109
 - level
 - classification, 123
 - location information, 119–121, 229
 - mal-actor, 138
 - military
 - IEEE 802.11i, 41
 - non-cryptographic, 108
 - requirements, 108–109
 - access control, 108
 - application, 109

- authentication, 108
- authorization, 108
- entity association, 232
- entity authentication, 108, 232
- importance, 109
- non-repudiation, 108
- revocation list, 117, 121, 123
 - encoding, 118
 - Fountain codes, 118
 - Raptor codes, 118
- robustness, 115
- secure VC deployment, 124
- sensor adversary, 119
 - non-cryptographic protection, 119
- thread model, 107–108
- trust establishment
 - data centric, 122
- trustworthiness
 - assessment, 121
 - communication module, 123
 - data, 109, 119
 - level, 121
 - message, 121, 142
 - message sender, 119
 - position information, 120
 - sender, 108, 121, 142
 - system, 124
- Sensing
 - infrastructure-based, 177
- Simulation
 - driver model, 225
 - driving, 207
 - IEEE 1609.4
 - multichannel MAC, 64
 - intelligent vehicle
 - SUMMITS, 214–215
 - microscopic traffic
 - SUMMITS, 207
 - performance evaluation
 - multichannel MAC, 63
 - system robustness
 - MARS, 212
 - traffic flow
 - ITS modeller, 218
 - scenarios, 221–224
 - throughput optimization, 208, 224
 - traffic model, 224
 - traffic pattern, 224
 - VANET
 - information dissemination, 74
 - safety applications, 24
 - VANET performance limits, 3
 - vehicle model, 225
- Spectrum
 - allotment
 - DSRC, 46
 - digital dividend, 259
 - DSA, *see* Dynamic Spectrum Access
 - dynamic access, 259
 - license by rule, 173
 - license-exempt use, 93
 - licensing
 - exclusive, 93
 - V2I, 160
 - licensing cost, 38
 - spectrum handover, 266
 - whitespace, 259
- Standardization
 - automotive
 - ASTM, 157
 - C2C-CC, 161, 175
 - COMeSafety, 161
 - ETSI ITS, 161, 172, 173
 - Europe, 160–162
 - global, 163–168
 - global organizations, 164–168
 - IEEE WAVE, 65, 77, 109, 158–160, 165, 167, 174, 178, 235
 - ISO CALM, 161, 164–165, 167, 174, 176, 187, 191
 - ISO TC 204, 164
 - ISO TC 22, 164
 - ITU-T APSC TELEMov, 167
 - Japan, 162–163
 - North America, 157–160
 - regional differences, 167
 - regional progress, 157–163
 - cooperation, 156–157
 - motivation, 156
 - protocol layers, 156
 - insufficiency, 154
 - interoperability, 38, 150, 154
 - security, 154
 - military
 - FIPS-140, 41
 - necessity, 153
 - message set, 153
 - radio, 153
 - rules of use, 154
 - protocols
 - activities, 155
 - OSI model, 154–155

- railway
 - IEC TCN, 99, 100
 - regional aspects, 152
- Standardization body
 - ARIB, 46, 162–163
 - CEN, 160
 - CENELEC, 161
 - ETSI, 93, 161, 172, 175
 - IEC, 100, 161
 - IEEE, 155
 - IETF, 155, 175, 186
 - ISO, 100, 155, 160, 164, 174
 - ITU-R, 165
 - ITU-T, 167
 - NIST, 41
 - SAE, 159
 - TIA, 37
 - UIC, 96
- SUMMITS, *see* Sustainable Mobility
 - Methodologies for Intelligent Transport Systems
 - assessment
 - meta-model, 206, 207
 - multi-aspect, 205
 - speed assistant, 208–212
 - IRSA, 208–212
 - impact on traffic flow, 218–219
 - implementation, 213–215, 219–221
 - ITS modeller, 218
 - MARS, 213–215
 - tool-suite, 206
 - overview, 204
 - tools, 206–207
- Testing
 - cooperative system
 - scenarios, 177
 - on-road
 - SUMMITS, 207
 - security
 - challenges, 125
- TNO, *see* Netherlands Organization for Applied Scientific Research
 - SUMMITS, 204
- Traffic Control System
 - train control
 - cab signal system, 132
 - train operations
 - Direct Traffic Control, 131
 - Track Warrant Control, 131
 - centralized, 131
 - mandatory directives, 131
 - operating rules, 130, 131
 - verbal authorities, 131
- Traffic management
 - automotive
 - protocol, 158
 - rail traffic
 - ERTMS, 85, 101, 173
- Train control
 - PTC, *see* Positive Train Control
 - OSI application layer protocol, 138
 - accounting management, 145
 - architecture, 134–135, 240–241
 - central office, 135
 - configuration management, 145
 - fault management, 145
 - full system, 133
 - functional levels, 133, 229
 - on-board subsystem, 134
 - overlay system, 133
 - performance management, 144
 - security management, 146
 - track database, 144
 - wayside subsystem, 135
 - Train control system
 - ATC, *see* Automatic Train Control, 84, 88–89, 94, 132
 - full ATC, 89
 - ATP, *see* Automatic Train Protection, 88
 - Automatic Train Stop, 132
 - ETCS, *see* European Train Control System, 85, 102, 258
 - Eurobalise, 102
 - Euroloop, 102
 - MODURBAN, 102
 - PTC, *see* Positive Train Control
 - Advanced Civil Speed Enforcement System, 136
 - Collision Avoidance System, 136
 - Communications-Based Train Management, 136
 - Electronic Train Management System, 136
 - Incremental Train Control System, 136
 - North American Joint Positive Train Control System, 136
 - operational in the US, 135–138
 - Optimized Train Control, 136
 - Train Sentinel, 136
 - Vital Train Management System, 136

- speed control
 - KVB, 84
- UIC, *see* Union Internationale des Chemins de Fer, 96
- V2I, *see* Vehicle-to-Infrastructure communication
 - 3GPP LTE, 173, 181–184
 - 3GPP LTE beyond, 259
 - EDGE, 98
 - GPRS, 97, 98, 118, 181
 - GSM, 97, 98, 181
 - HSDPA, 182
 - IMT-Advanced, 259
 - IP-based, 186–196
 - mobile WiMAX, 184
 - non-IP, 185–186
 - radio channel, *see also* V2X radio channel
 - V2I fading model, 50
 - UMTS, 98, 118, 182, 183, 187
 - WiMAX, 173, 184
 - IEEE 802.16e, 184
 - IEEE 802.16m, 184
- V2X, *see* Vehicle-to-Vehicle/Infrastructure communication
 - C2C-CC, 175
 - collaboration and cooperation, 265–267
 - IP-based group communication, 194
 - radio channel, 48–57
 - absorption, 50
 - characteristics, 179
 - coherence bandwidth, 57, 179
 - coherence time, 54, 50, 179
 - delay spread profile, 56
 - deterministic model, 48
 - diffraction, 50
 - Doppler spread, 53, 59
 - Doppler tracking, 180
 - dual slope log-normal model, 49, 51
 - effective velocity, 56
 - equalization, 59, 60, 77, 179
 - estimation, 179, 180, 182
 - fading statistics, 53
 - frequency selective fading, 57
 - geometry-based model, 48
 - impact of driver behavior, 55
 - impact on OFDM, 59
 - inter-carrier interference, 183
 - large-scale model, 50, 53
 - large-scale path loss, 51
 - measurement system, 51
 - measurements, 51, 231
 - multi-tap model, 50
 - multipath fading, 48–50
 - railway, 92
 - ray-tracing, 48
 - scattering, 50
 - small-scale fading model, 49
 - sounding, 51, 182
 - time-dispersive, 50
 - two-ray flat-earth model, 48
 - V2V fading model, 50
 - V2V channel properties, 51
 - VANET, *see* Vehicular Ad hoc Network, 4, 161
 - application
 - neighbor table, 113
 - safety beacon, 112
 - security, 102
 - application characteristics, 8–10
 - event correlation, 10
 - event detection, 10, 13
 - event lifetime, 9
 - information recipients, 9, 13
 - participants, 9
 - Region-of-Interest, 9, 13
 - trigger condition, 9, 13
 - user benefit, 8
 - application characterization, 12–18
 - by application characteristics, 12–15
 - by network attributes, 15–18
 - application classification, 18–21
 - content download/streaming, 19
 - short message communication, 18
 - application reliability, 68–69
 - metric, 69
 - broadcast
 - broadcast storm, 71
 - contention-based, 72
 - flooding, 72
 - reliability, 66–68
 - sparse VANET, 73
 - certificate revocation
 - RSU distributed, 117
 - vehicle distributed, 118
 - deployment
 - aftermarket, 22
 - applications, 24
 - infrastructure, 25
 - market centric, 124
 - market penetration, 23

- navigation, 21
- penetration, 21
- rollout options, 21–23
- safety applications, 24
- standalone system, 21
- system rollout, 25
- telematics, 22
- vertical market, 33
- military
 - security, 41
 - UAV, 41
 - use cases, 40–41
- multi-hop, 7, 20, 24, 41, 71–73, 78, 111, 161
- network attributes, 10–12
 - broadcasting, 12
 - channel, 10
 - information lifetime, 11
 - infrastructure, 11, 17
 - message format, 11, 15
 - message transport, 12
 - message trigger, 12, 17
 - routing protocol, 11, 15
 - security, 12, 231
- protocol
 - DHCP, 76
 - information dissemination, 71, 185
 - MANET, 76
 - mobile IP, 75–77
 - NEMO, 76
- public safety
 - use cases, 35, 39–40
- reliability enhancement
 - broadcast, 69
- routing
 - Ad hoc On Demand Distance Vector Routing (AODV), 74
 - Dynamic Source Routing (DSR), 74
 - epidemic, 73
 - geographical, 185
 - geographical message forwarding, 113, 186, 259
 - geographical packet forwarding, 113, 186, 259
 - security, 113
- security
 - neighbor discovery, 112–113
 - routing, 113
- VC, *see* Vehicular Communication
 - application vs. communication
 - reliability, 67, 69, 230
 - CR, *see also* Cognitive Radio, 266
 - cryptographic overhead, 116
 - evolution, 259, 265
 - Internet of things, 265
 - Machine-to-machine communication, 265
 - military, 40–42
 - mobile WiMAX, 185
 - public safety, 31–34
 - challenges, 35
 - homeland security, 35
 - traceability, 125
 - VoIP, 30
 - SDR, 266
 - security
 - legal considerations, 125
 - policies, 125
 - traffic class
 - non real time message data, 86
 - real time data, 85
 - streaming data, 88
- Wi-Fi
 - Access Point Transition Time, *see* APTT
 - handover delay, 95, 237, 239
 - APTT, 245
 - service interruption time, *see* handover delay
 - wireless sensor network, 196–198, 265
 - low power, 198
 - on-board, 196
- VC application, *see also* VSC application
 - Amber alert, 37
 - audio streaming, 90
 - automated tolling, 6, 158, 161
 - benefit, 5–7
 - classification
 - content download/streaming, 19
 - short message communication, 18
 - commercial, 5, 7
 - convenience, 5, 6, 151
 - DTV transition, 162, 259
 - electronic report, 30
 - enhanced navigation, 158
 - future Internet, 265
 - information displays, 89
 - information sharing, 40
 - integrated detection systems, 40
 - Internet access, 91
 - large-scale device monitoring, 194
 - maintenance, 91

- PIS, *see* Passenger Information System, 89–91
- position-based, 119, 163
- predictive maintenance, 84
- rapid deployment, 40
- remote diagnostic, 196
- remote repair, 196
- remote situation analysis, 37
- Seat Reservation Display, 89
- software update, 91, 194, 196
- surveillance, 32
- traffic management, 5, 158, 177
- train management, 136
- transportation efficiency, 6
- VANEMO, 76
- VANET, 109, 122
- vehicle tracing, 40
- video streaming, 32, 90
- VoIP, 30–32, 37
- VeHIL, *see* Vehicle Hardware In the Loop, 207
- VSC, *see* Vehicular Safety Communication
 - packet loss, 181
 - WiMAX
 - safety message latency, 185
- VSC application, *see also* VC application
 - CCTV, 90
 - Basic Safety Message set, 159
 - collision avoidance, 136, 158
 - cooperative awareness, 119, 177
 - crash avoidance, 150
 - driver assistance, 5
 - intersection collision avoidance, 151
 - malfunction identification, 196
 - road safety, 177
 - soft safety, 151
 - speed control, 84
 - speed enforcement, 136
 - traffic safety, 150
 - train control, 136
 - VANET, 63, 68
 - vehicle safety, 5