

1. Record Nr.	UNINA9910467004103321
Autore	Kukushkin Alexander
Titolo	Introduction to mobile network engineering : GSM, 3G-WCDMA, LTE and the road to 5G // by Alexander Kukushkin
Pubbl/distr/stampa	Hoboken, New Jersey : , : John Wiley & Sons, , 2018 [Piscataway, New Jersey] : , : IEEE Xplore, , [2018]
ISBN	1-119-48410-3 1-119-48422-7 1-119-48419-7
Descrizione fisica	1 online resource (491 pages)
Disciplina	621.3845/6
Soggetti	Mobile communication systems Wireless metropolitan area networks Electronic books.
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Foreword xvii / /Acknowledgements xix -- Abbreviations xxi -- 1 Introduction 1 -- 2 Types of Mobile Network by Multiple-Access Scheme 3 -- 3 Cellular System 5 -- 3.1 Historical Background 5 -- 3.2 Cellular Concept 5 -- 3.3 Carrier-to-Interference Ratio 6 -- 3.4 Formation of Clusters 8 -- 3.5 Sectorization 9 -- 3.6 Frequency Allocation 10 -- 3.7 Trunking Eﬀect 11 -- 3.8 Erlang Formulas 13 -- 3.9 Erlang B Formula 13 -- 3.10 Worked Examples 14 -- 3.10.1 Problem 1 14 -- 3.10.2 Problem 2 16 -- 3.10.3 Problem 3 16 -- 4 Radio Propagation 19 -- 4.1 Propagation Mechanisms 19 -- 4.1.1 Free-Space Propagation 19 -- 4.1.2 Propagation Models for Path Loss (Global Mean) Prediction 22 -- 5 Mobile Radio Channel 27 -- 5.1 Channel Characterization 28 -- 5.1.1 Narrowband Flat Channel 31 -- 5.1.2 Wideband Frequency Selective Channel 31 -- 5.1.3 Doppler Shift 34 -- 5.2 Worked Examples 36 -- 5.2.1 Problem 1 36 -- 5.2.2 Problem 2 36 -- 5.3 Fading 36 -- 5.3.1 Shadowing/Slow Fading 37 -- 5.3.2 Fast Fading/Rayleigh Fading 40 -- 5.4 Diversity to Mitigate Multipath Fading 42 -- 5.4.1 Space and Polarization Diversity 42 -- 5.5 Worked Examples 44 -- 5.5.1 Problem 1 44 -- 5.5.2 Problem 2 44 -- 5.5.3

Problem 3 45 -- 5.6 Receiver Noise Factor (Noise Figure) 45 -- 6 Radio Network Planning 49 -- 6.1 Generic Link Budget 49 -- 6.1.1 Receiver Sensitivity Level 50 -- 6.1.2 Design Level 50 -- 6.1.2.1 Rayleigh Fading Margin 51 -- 6.1.2.2 Lognormal Fading Margin 51 -- 6.1.2.3 Body Loss 51 -- 6.1.2.4 Car Penetration Loss 51 -- 6.1.2.5 Design Level 51 -- 6.1.2.6 Building Penetration Loss 52 -- 6.1.2.7 Outdoor-to-Indoor Design Level 52 -- 6.1.3 Power Link Budget 52 -- 6.1.4 Power Balance 53 -- 6.2 Worked Examples 56 -- 6.2.1 Problem 1 56 -- 6.2.2 Problem 2 57 -- 6.2.3 Problem 3 58 -- 7 Global System Mobile, GSM, 2G 59 -- 7.1 General Concept for GSM System Development 59 -- 7.2 GSM System Architecture 59 -- 7.2.1 Location Area Identity (LAI) 62 -- 7.2.2 The SIM Concept 63 -- 7.2.3 User Addressing in the GSM Network 63. 7.2.4 International Mobile Station Equipment Identity (IMEI) 63 -- 7.2.5 International Mobile Subscriber Identity (IMSI) 64 -- 7.2.6 Different Roles of MSISDN and IMSI 64 -- 7.2.7 Mobile Station Routing Number 64 -- 7.2.8 Calls to Mobile Terminals 65 -- 7.2.9 Temporary Mobile Subscriber Identity (TMSI) 66 -- 7.2.10 Security-Related Network Functions: Authentication and Encryption 66 -- 7.2.11 Call Security 67 -- 7.2.12 Operation and Maintenance Security 69 -- 7.3 Radio Specifications 69 -- 7.3.1 Spectrum Efficiency 69 -- 7.3.2 Access Technology 71 -- 7.3.3 MAHO and Measurements Performed by Mobile 72 -- 7.3.4 Time Slot and Burst 73 -- 7.3.4.1 Normal Burst 74 -- 7.3.4.2 Frequency Correction Burst (FB) 74 -- 7.3.4.3 Synchronization Burst 75 -- 7.3.4.4 Access Burst 75 -- 7.3.4.5 Dummy Burst 75 -- 7.3.5 GSM Adaptation to a Wideband Propagation Channel 76 -- 7.3.5.1 Training Sequence and Equalization 76 -- 7.3.5.2 The Channel Equalization 77 -- 7.3.5.3 Diversity Against Fast Fading 78 -- 7.3.5.4 Frequency Hopping 79 -- 7.4 Background for the Choice of Radio Parameters 81 -- 7.4.1 Guard Period, Timing Advance 83 -- 7.5 Communication Channels in GSM 84 -- 7.5.1 Traffic Channels (TCHs) 84 -- 7.5.2 Control Channels 85 -- 7.5.2.1 Common Control Channels 85 -- 7.5.2.2 Dedicated Control Channels 86 -- 7.6 Mapping the Logical Channels onto Physical Channels 86 -- 7.6.1 Frame Format 87 -- 7.6.2 Transmission of User Information: Fast Associated Control Channel 88 -- 7.6.2.1 Data Rates 88 -- 7.6.3 Signalling Multiframe, 51-Frame Multiframe 88 -- 7.6.4 Synchronization 89 -- 7.6.4.1 Frequency Synchronization 90 -- 7.6.4.2 Time Synchronization 90 -- 7.6.5 Signalling Procedures over the Air Interface 90 -- 7.6.5.1 Synchronization to the Base Station 90 -- 7.6.5.2 Registering With the Base Station 91 -- 7.6.5.3 Call Setup 91 -- 7.7 Signalling During a Call 93 -- 7.7.1 Measuring the Signal Levels from Adjacent Cells 93 -- 7.7.2 Handover 94 -- 7.7.2.1 Intra-Cell and Inter-Cell Handover 95. 7.7.2.2 Intra- and Inter-BSC Handover 95 -- 7.7.2.3 Intra- and Inter-MSB Handover 95 -- 7.7.2.4 Intra- and Inter-PLMN Handover 95 -- 7.7.2.5 Handover Triggering 95 -- 7.7.3 Power Control 96 -- 7.8 Signal Processing Chain 97 -- 7.8.1 Speech and Channel Coding 97 -- 7.8.2 Reordering and Interleaving of the TCH 99 -- 7.9 Estimating Required Signalling Capacity in the Cell 100 -- 7.9.1 SDCCH Configuration 100 -- 7.9.2 Worked Example 101 -- 7.9.2.1 Problem 1 101 -- References 102 -- 8 EGPRS: GPRS/EDGE 103 -- 8.1 GPRS Support Nodes 103 -- 8.2 GPRS Interfaces 104 -- 8.3 GPRS Procedures in Packet Call Setups 104 -- 8.4 GPRS Mobility Management 105 -- 8.4.1 Mobility Management States 106 -- 8.4.1.1 IDLE State 106 -- 8.4.1.2 READY State 106 -- 8.4.1.3 STANDBY State 106 -- 8.4.2 PDP Context Activation 107 -- 8.4.3 Location Management 108 -- 8.5 Layered Overview of the Radio Interface 108 -- 8.5.1 SNDCP 108 -- 8.5.2 Layer Services 109 -- 8.5.3 Radio Link Layer 110 -- 8.5.3.1

RLC Block Structure 110 -- 8.5.4 GPRS Logical Channels 111 -- 8.5.5 Mapping to Physical GPRS Channels 111 -- 8.5.6 Channel Sharing 112 -- 8.5.6.1 Downlink Radio Channel 113 -- 8.5.6.2 Uplink Radio Channel 113 -- 8.5.7 TBF 113 -- 8.5.7.1 TBF Establishment 113 -- 8.5.7.2 DL TBF Establishment 113 -- 8.5.8 EGPRS Channel Coding and Modulation 15 -- 8.6 GPRS/GSM Territory in a Base-Station Transceiver 115 -- 8.6.1 PS Capacity in the Base Station/Cell 116 -- 8.7 Summary 118 -- References 119 -- 9 Third Generation Network (3G), UMTS 121 -- 9.1 The WCDMA Concept 123 -- 9.1.1 Spreading (Channelization) 124 -- 9.1.2 Scrambling 127 -- 9.1.3 Multiservice Capacity 128 -- 9.1.4 Power Control 129 -- 9.1.4.1 Open-Loop Power Control 130 -- 9.1.4.2 Outer-Loop Power Control 130 -- 9.1.5 Handover 132 -- 9.1.5.1 Softer Handover 132 -- 9.1.5.2 Other Handovers 134 -- 9.1.5.3 Compressed Mode 134 -- 9.1.6 RAKE Reception 135 -- 9.2 Major Parameters of 3G WCDMA Air Interface 136 -- 9.3 Spectrum Allocation for 3G WCDMA 136 -- 9.4 3G Services 138. 9.4.1 Bearer Service and QoS 138 -- 9.5 UMTS Reference Network Architecture and Interfaces 140 -- 9.5.1 The NodeB (Base Station) Functions in the 3G Network 141 -- 9.5.2 Role of the RNC in 3G Network 141 -- 9.6 Air-Interface Architecture and Processing 142 -- 9.6.1 Physical Layer (Layer 1) 144 -- 9.6.2 Medium Access Control (MAC) on Layer 2 144 -- 9.6.3 Radio Link Control (RLC) on Layer 2 145 -- 9.6.4 RRC on Layer 3 in the Control Plane 145 -- 9.7 Channels on the Air Interface 146 -- 9.7.1 Logical Channels 146 -- 9.7.2 Transport Channels 146 -- 9.7.2.1 Dedicated Transport Channel (DCH) 147 -- 9.7.2.2 Common Transport Channels 147 -- 9.7.3 Physical Channels and Physical Signals 148 -- 9.7.4 Parameters of the Transport Channel 148 -- 9.8 Physical-Layer Procedures 150 -- 9.8.1 Processing of Transport Blocks 151 -- 9.8.2 Spreading and Modulation 154 -- 9.8.3 Modulation Scheme in UTRAN FDD 155 -- 9.8.4 Composition of the Physical Channels 157 -- 9.8.4.1 Dedicated Physical Channel 157 -- 9.8.4.2 Common Downlink Physical Channels 160 -- 9.9 RRC States 162 -- 9.9.1 Idle Mode 162 -- 9.9.2 RRC Connected Mode 164 -- 9.9.3 RRC Connection Procedures 165 -- 9.9.4 RRC State Transition Cases 166 -- 9.10 RRM Functions 167 -- 9.10.1 Admission Control Principle 167 -- 9.10.2 Load/Congestion Control 168 -- 9.10.3 Code Management 168 -- 9.10.4 Packet Scheduling 168 -- 9.11 Initial Access to the Network 169 -- 9.12 Summary 170 -- References 171 -- 10 High-Speed Packet Data Access (HSPA) 173 -- 10.1 HSDPA, High-Speed Downlink Packet Data Access 173 -- 10.2 HSPA RRM Functions 175 -- 10.2.1 Channel-Dependent Scheduling for HS-DSCH 175 -- 10.2.2 Rate Control, Dynamic Resource Allocation, Adaptive Modulation and Coding 176 -- 10.2.3 Hybrid-ARQ with Soft Combining, HARQ 176 -- 10.2.4 Retransmission Mechanism in the NodeB 176 -- 10.2.5 Impact to Protocol Architecture 177 -- 10.2.6 HARQ Schemes 178 -- 10.3 MAC-hs and Physical-Layer Processing 181 -- 10.4 HSDPA Channels 182 -- 10.4.1 High-Speed Downlink Shared Channel (HS-DSCH) 182. 10.4.2 HSDPA Control Channels 183 -- 10.4.2.1 Fractional Downlink Power Control Channel 184 -- 10.4.3 HS-DSCH Link Adaptation 184 -- 10.5 HSUPA (Enhanced Uplink, E-DCH) 189 -- 10.5.1 Control Signalling 190 -- 10.5.2 Scheduling 190 -- 10.6 Air-Interface Dimensioning 192 -- 10.6.1 Input Parameters and Requirements 192 -- 10.6.2 Traffic Demand Estimation 193 -- 10.6.2.1 PS Data Services (Release 99) 193 -- 10.6.2.2 HSPA Data Services 193 -- 10.6.3 Standard Traffic Model 194 -- 10.6.4 Link Budgets 195 -- 10.6.4.1 Uplink Load Factor 196 -- 10.6.4.2 Downlink Load Factor 197 -- 10.6.4.3 Link Budget for R99 Bearers 198 -- 10.6.4.4 Link Budget

for HSPA 199 -- 10.6.4.5 Results of Link Budget: Cell Range Calculation, Balancing UL with DL 199 -- 10.6.4.6 Link Budget for Common Pilot Channel Signal 200 -- 10.6.4.7 Link Budget Calculation for the Shared Release 99 and HSDPA Carriers 200 -- 10.6.5 Uplink Capacity Estimation 201 -- 10.6.5.1 Required Bandwidth and Load for Multiple Bearers with GOS Considerations 202 -- 10.6.5.2 Simplified Estimation of HSDPA Throughput Capacity 202 -- 10.7 Summary 203 -- References 204 -- 11 4G-Long Term Evolution (LTE) System 205 -- 11.1 Introduction 205 -- 11.2 Architecture of an Evolved Packet System 206 -- 11.3 LTE Integration with Existing 2G/3G Network 207 -- 11.3.1 EPS Reference Points and Interfaces 208 -- 11.4 E-UTRAN Interfaces 209 -- 11.5 User Equipment 210 -- 11.5.1 LTE UE Category 210 -- 11.6 QoS in LTE 211 -- 11.7 LTE Security 212 -- 11.8 LTE Mobility 214 -- 11.8.1 Idle Mode Mobility 214 -- 11.8.2 ECM-CONNECTED Mode Mobility 215 -- 11.8.3 Mobility Anchor 216 -- 11.8.4 Inter-eNB Handover 216 -- 11.8.5 3GPP Inter-RAT Handover 218 -- 11.8.6 Differences in E-UTRAN and UTRAN Mobility 218 -- 11.9 LTE Radio Interface 219 -- 11.10 Principle of OFDM 220 -- 11.11 OFDM Implementation using IFFT/FFT Processing 223 -- 11.12 Cyclic Prefix 223 -- 11.13 Channel Estimation and Reference Symbols 225 -- 11.14 OFDM Subcarrier Spacing 227. 11.15 Output RF Spectrum Emissions 227 -- 11.16 LTE Multiple-Access Scheme, OFDMA 228 -- 11.17 Single-Carrier FDMA (SC-FDMA) 229 -- 11.18 OFDMA versus SC-FDMA Operation 230 -- 11.19 SC-FDMA Receiver 231 -- 11.20 User Multiplexing with DFTS-OFDM 231 -- 11.21 MIMO Techniques 232 -- 11.21.1 Precoding 234 -- 11.21.2 Cyclic Delay Diversity (CDD) 236 -- 11.22 Link Adaptation and Frequency Domain Packet Scheduling 237 -- 11.23 Radio Protocol Architecture 238 -- 11.23.1 User Plane 239 -- 11.23.2 Control Plane 239 -- 11.23.3 Scheduler 240 -- 11.23.4 Logical and Transport Channels 240 -- 11.23.5 Physical Layer 242 -- 11.23.6 RRC State Machine 244 -- 11.23.7 Time-Frequency Structure of the LTE FDD Physical Layer 244 -- 11.24 Downlink Physical Layer Processing 248 -- 11.24.1 Multiplexing and Channel Coding for Downlink Transport Channels 248 -- 11.24.2 CRC Computation and Attachment to the Transport Block 248 -- 11.24.3 Code Block Segmentation and Code Block CRC Attachment 249 -- 11.24.4 Channel Coding 249 -- 11.24.5 Rate Matching for Turbo Coded Transport Channels 249 -- 11.24.6 Downlink Control Information Coding 250 -- 11.24.7 Physical Channel Processing 250 -- 11.24.7.1 Bit-Level Scrambling 251 -- 11.24.7.2 Data Modulation 251 -- 11.24.7.3 Layer Mapping 252 -- 11.24.7.4 Precoding 252 -- 11.24.7.5 Mapping to Resource Elements 255 -- 11.24.7.6 Downlink Reference Signals 256 -- 11.25 Downlink Control Channels 258 -- 11.25.1 Structure of the Synchronization Channel 258 -- 11.25.2 Time-Domain Position of Synchronization Signals 259 -- 11.25.3 Frequency Domain Structure of Synchronization Signals 259 -- 11.25.3.1 PSS Structure 259 -- 11.25.3.2 SSS Structure 260 -- 11.25.4 PBCH 260 -- 11.25.5 Physical Control Format Indicator Channel: PCFICH 262 -- 11.25.6 PDCCH 263 -- 11.25.7 PHICH, Physical Hybrid-ARQ Indicator Channel 264 -- 11.26 Mapping the Control Channels to Downlink Transmission Resources 264 -- 11.27 Uplink Control Signalling 264 -- 11.27.1 Processing of the Uplink Shared Transport Channel 266. 11.27.2 Channel Coding of Control Information 266 -- 11.27.3 Multiplexing and Channel Interleaving 266 -- 11.27.4 Processing for Physical Uplink Shared Channel 268 -- 11.27.5 Physical Uplink Control Channel, PUCCH 269 -- 11.27.6 Multiplexing of UEs Within a PUCCH 269 -- 11.27.7 Physical Random Access Channel (PRACH) 270 -- 11.28

Uplink Reference Signals 271 -- 11.28.1 Mapping of Reference Signals to the Uplink Frame Structure 272 -- 11.29 Physical-Layer Procedures 273 -- 11.29.1 Cell Search 273 -- 11.29.2 Random Access Procedure 274 -- 11.29.3 Link Adaptation 276 -- 11.29.4 Power Control 277 -- 11.29.5 Paging 278 -- 11.29.6 HARQ 278 -- 11.30 LTE Radio Dimensioning 279 -- 11.30.1 LTE Coverage Dimensioning: Link Budget 280 -- 11.30.1.1 Physical-Layer Overhead Factors 281 -- 11.30.1.2 Multi-Antenna Systems 284 -- 11.30.1.3 Required SINR 285 -- 11.30.1.4 Link Budget Margins 285 -- 11.30.1.5 Interference Margin 285 -- 11.30.1.6 Maximum Allowable Path Loss (MAPL) 287 -- 11.30.1.7 Required SINR 288 -- 11.30.2 Cell Range and Cell Capacity 288 -- 11.31 Summary 289 -- References 290 -- 12 LTE-A 293 -- 12.1 Carrier Aggregation 296 -- 12.2 Enhanced MIMO 300 -- 12.3 Coordinated Multi-Point Operation (CoMP) 303 -- 12.3.1 CoMP Categories 304 -- 12.3.2 Downlink CoMP 306 -- 12.3.3 Uplink CoMP 307 -- 12.4 Relay Nodes 309 -- 12.4.1 Relay Radio Access 309 -- 12.4.2 Relay Architecture 311 -- 12.4.3 Resource Assignment for DeNB-RN Link in a Type 1 Relay 314 -- 12.5 Enhanced Physical Downlink Control Channel (E-PDCCH) 315 -- 12.6 Downlink Multiuser Superposition, MUST 315 -- 12.7 Summary of LTE-A Features 317 -- References 317 -- 13 Further Development for the Fifth Generation 319 -- 13.1 Overall Operational Requirements for a 5G Network System 320 -- 13.2 Device Requirements 320 -- 13.3 Capabilities of 5G 321 -- 13.4 Spectrum Consideration 321 -- 13.5 5G Technology Components 322 -- 13.5.1 Technologies to Enhance the Radio Interface 322 -- 13.5.1.1 Advanced Modulation-and-Coding Schemes 323. 13.5.1.2 Non-Orthogonal Multiple Access (NOMA) 323 -- 13.5.1.3 Active Antenna System (AAS) 326 -- 13.5.1.4 3D Beamforming and Multiuser MIMO (MU-MIMO) 327 -- 13.5.1.5 Massive MIMO 328 -- 13.5.1.6 Full Duplex Mode 329 -- 13.5.1.7 Self-Backhauling 330 -- 13.5.2 Technologies to Enhance Network Architectures 331 -- 13.5.2.1 Software-Defined Network 332 -- 13.5.2.2 Cloud RAN 332 -- 13.5.2.3 Network Slicing 332 -- 13.5.2.4 Self-Organized Network, SON 334 -- 13.6 5G System Architecture (Release 15) 335 -- 13.6.1 General Concepts 335 -- 13.6.2 Architecture Reference Model 335 -- 13.6.3 Network Slicing Support 338 -- 13.6.3.1 General Framework 338 -- 13.6.3.2 Network Slice Selection Assistance Information (NSSAI) 338 -- 13.6.3.3 Selection of a Serving AMF Supporting the Network Slices 339 -- 13.6.3.4 UE Context Handling 340 -- 13.7 New Radio (NR) 341 -- 13.7.1 NG-RAN Architecture 341 -- 13.7.2 Functional Split 342 -- 13.7.3 Network Interfaces 343 -- 13.7.3.1 NG Interface 343 -- 13.7.4 Xn Interface 345 -- 13.7.5 NG-RAN Distributed Architecture 346 -- 13.7.5.1 F1 Interface Functions 347 -- 13.7.5.2 F1 Protocol Structure 347 -- 13.7.6 Radio Protocol Architecture 348 -- 13.7.6.1 User Plane 348 -- 13.7.7 NR Physical Channels and Modulation 350 -- 13.7.7.1 Physical-Layer Design Requirements 350 -- 13.7.7.2 Frame Structure and Physical Resources 352 -- 13.7.8 Frames and Subframes 353 -- 13.7.9 Physical Resources 354 -- 13.7.9.1 Resource Grid 354 -- 13.7.9.2 Resource Blocks 355 -- 13.7.10 Carrier Aggregation 356 -- 13.7.11 Uplink Physical Channels and Signals 356 -- 13.7.12 Downlink Physical Channels and Signals 357 -- 13.7.13 SS/PBCH Block 358 -- 13.7.14 Coding and Multiplexing 359 -- 13.7.15 NR Dual Connectivity 359 -- 13.7.16 E-UTRA and NR Multi-RAT Dual Connectivity 360 -- 13.7.16.1 Bearer Types for MR-DC Between LTE and NR 362 -- 13.7.16.2 MR-DC User-Plane Connectivity 363 -- 13.8 Summary 364 -- References 364 -- 14 Annex: Base-Station Site Solutions 367 -- 14.1 The Base-Station OBSAI Architecture 367.

14.1.1 Functional Modules 367 -- 14.1.2 Internal Interfaces 369 --
14.1.3 RP3 Interface 369 -- 14.2 Common Public Radio Interface, CPRI
370 -- 14.3 SDR and Multiradio BTS 371 -- 14.4 Site Solution with
OBSAI Type Base Stations 372 -- 14.4.1 C-RAN Site Solutions 374 --
References 375 -- Index 377.

Sommario/riassunto

SUMMARIZES AND SURVEYS CURRENT LTE TECHNICAL SPECIFICATIONS AND IMPLEMENTATION OPTIONS FOR ENGINEERS AND NEWLY QUALIFIED SUPPORT STAFF

Concentrating on three mobile communication technologies, GSM, 3G-WCDMA, and LTE; while majorly focusing on Radio Access Network "RAN" technology; this book describes principles of mobile radio technologies that are used in mobile phones and service providers' infrastructure, supporting their operation. It introduces some basic concepts of mobile network engineering used in design and rollout of the mobile network. It then follows up with principles, design constraints, and more advanced insights into radio interface protocol stack, operation, and dimensioning for three major mobile network technologies: Global System Mobile "GSM" and third "3G" and fourth generation "4G" mobile technologies. The concluding sections of the book are concerned with further developments toward next generation of mobile network "5G". Those include some of the major features of 5G such as a New Radio, NG-RAN distributed architecture, and network slicing. The last section describes some key concepts that may bring significant enhancements in future technology and services experienced by customers.

Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G covers the types of Mobile Network by Multiple Access Scheme; the cellular system; radio propagation; mobile radio channel; radio network planning; EGPRS - GPRS/EDGE; Third Generation Network "3G", UMTS; High Speed Packet data access "HSPA"; 4G-Long Term Evolution "LTE" system; LTE-A; and Release 15 for 5G. . Focuses on Radio Access Network technologies which empower communications in current and emerging mobile network systems. Presents a mix of introductory and advanced reading, with a generalist view on current mobile network technologies. Written at a level that enables readers to understand principles of radio network deployment and operation. Fully illustrated with tables, figures, photographs, working examples with problems and solutions, and section summaries highlighting the key features of each technology described

Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G is an ideal text for postgraduate and graduate students studying wireless engineering and industry professionals requiring an introduction or refresher to existing technologies.
