
Contents

Preface to the Second Edition ix

Preface to the First Edition x

Acknowledgments xii

Chapter 1. Introduction to Cellular Mobile Systems 1

- 1.1 Why Cellular Mobile Telephone Systems? / 1
- 1.2 History of 800-MHz Spectrum Allocation / 2
- 1.3 Trunking Efficiency / 6
- 1.4 A Basic Cellular System / 7
- 1.5 Performance Criteria / 9
- 1.6 Uniqueness of Mobile Radio Environment / 11
- 1.7 Operation of Cellular Systems / 25
- 1.8 Marketing Image of Hexagonal-shaped Cells / 27
- 1.9 Planning a Cellular System / 27
- 1.10 Analog Cellular Systems / 29
- 1.11 Digital Cellular Systems / 33

Chapter 2. Elements of Cellular Radio System Design 53

- 2.1 General Description of the Problem / 53
- 2.2 Concept of Frequency Reuse Channels / 56
- 2.3 Cochannel Interference Reduction Factor / 59
- 2.4 Desired C/I from a Normal Case in an Omnidirectional Antenna System / 62
- 2.5 Handoff Mechanism / 65
- 2.6 Cell Splitting / 67
- 2.7 Consideration of the Components of Cellular Systems / 68

Chapter 3. Specifications of Analog Systems 73

- 3.1 Definitions of Terms and Functions / 73
- 3.2 Specification of Mobile Station (Unit) in the United States / 75
- 3.3 Specification of Land Station (United States) / 87
- 3.4 Different Specifications of the World's Analog Cellular Systems / 97

Chapter 4. Cell Coverage for Signal and Traffic 103

- 4.1 General Introduction / 103
- 4.2 Obtaining the Mobile Point-to-Point Model (Lee Model) / 106
- 4.3 Propagation over Water or Flat Open Area / 119
- 4.4 Foliage Loss / 124
- 4.5 Propagation in Near-in Distance / 126

- 4.6 Long-Distance Propagation / 129
- 4.7 Obtain Path Loss from a Point-to-Point Prediction Model—A General Approach / 131
- 4.8 Form of a Point-to-Point Model / 140
- 4.9 Computer Generation of a Point-to-Point Prediction / 143
- 4.10 Cell-Site Antenna Heights and Signal Coverage Cells / 146
- 4.11 Mobile-to-Mobile Propagation / 149

Chapter 5. Cell-Site Antennas and Mobile Antenna

157

- 5.1 Equivalent Circuits of Antennas / 157
- 5.2 The Gain-and-Pattern Relationship / 161
- 5.3 Sum-and-Difference Patterns—Engineering Antenna Pattern / 164
- 5.4 Antennas at Cell Site / 167
- 5.5 Unique Situations of Cell-Site Antennas / 177
- 5.6 Mobile Antennas / 180

Chapter 6. Cochannel Interference Reduction

189

- 6.1 Cochannel Interference / 189
- 6.2 Exploring Cochannel Interference Areas in a System / 189
- 6.3 Real-Time Cochannel Interference Measurement at Mobile Radio Transceivers / 192
- 6.4 Design of an Omnidirectional Antenna System in the Worst Case / 194
- 6.5 Design of a Directional Antenna System / 196
- 6.6 Lowering the Antenna Height / 202
- 6.7 Reduction of Cochannel Interference by Means of a Notch in the Tilted Antenna Pattern / 204
- 6.8 Umbrella-Pattern Effect / 209
- 6.9 Use of Parasitic Elements / 211
- 6.10 Power Control / 214
- 6.11 Diversity Receiver / 215
- 6.12 Designing a System to Serve a Predefined Area that Experiences Cochannel Interference / 217

Chapter 7. Types of Noncochannel Interference

221

- 7.1 Subjective Test versus Objective Test / 221
- 7.2 Adjacent-Channel Interference / 225
- 7.3 Near-End-Far-End Interference / 226
- 7.4 Effect on Near-End Mobile Units / 229
- 7.5 Cross Talk—A Unique Characteristic of Voice Channels / 233
- 7.6 Effects of Coverage and Interference by Applying Power Decrease, Antenna Height Decrease, Beam Tilting / 235
- 7.7 Effects on Cell-Site Components / 241
- 7.8 Interference between Systems / 247
- 7.9 UHF TV Interference / 250
- 7.10 Long-Distance Interference / 254

Chapter 8. Frequency Management and Channel Assignment

257

- 8.1 Frequency Management / 257
- 8.2 Frequency-Spectrum Utilization / 260

- 8.3 Set-up Channels / 260
- 8.4 Definition of Channel Assignment / 266
- 8.5 Fixed Channel Assignment / 268
- 8.6 Nonfixed Channel Assignment Algorithms / 274
- 8.7 How to Operate with Additional Spectrum / 277
- 8.8 Traffic and Channel Assignment / 279
- 8.9 Perception of Call Blocking from the Subscribers / 280

Chapter 9. Handoffs and Dropped Calls

283

- 9.1 Value of Implementing Handoffs / 283
- 9.2 Initiation of a Handoff / 286
- 9.3 Delaying a Handoff / 288
- 9.4 Forced Handoffs / 289
- 9.5 Queuing of Handoffs / 290
- 9.6 Power-Difference Handoffs / 292
- 9.7 Mobile Assisted Handoff (MAHO) and Soft Handoff / 294
- 9.8 Cell-Site Handoff Only / 295
- 9.9 Intersystem Handoff / 296
- 9.10 Introduction to Dropped Call Rate / 297
- 9.11 Formula of Dropped Call Rate / 299
- 9.12 Finding the Values of δ and μ / 302

Chapter 10. Operational Techniques and Technologies

307

- 10.1 Adjusting the Parameters of a System / 307
- 10.2 Coverage-Hole Filler / 311
- 10.3 Leaky Feeder / 319
- 10.4 Cell Splitting / 325
- 10.5 Small Cells (Microcells) / 328
- 10.6 Narrowbeam Concept / 334
- 10.7 Separation between Highway Cell Sites / 337
- 10.8 Low-Density Small-Market Design / 339

Chapter 11. Switching and Traffic

343

- 11.1 General Description / 343
- 11.2 Cellular Analog Switching Equipment / 349
- 11.3 Cellular Digital Switching Equipment / 352
- 11.4 Special Features for Handling Traffic / 355
- 11.5 MTSO Interconnection / 359
- 11.6 Small Switching Systems / 360
- 11.7 System Enhancement / 360

Chapter 12. Data Links and Microwaves

363

- 12.1 Data Links / 363
- 12.2 Available Frequencies for Microwave Links / 365
- 12.3 Microwave Link Design and Diversity Requirement / 366
- 12.4 Ray-Bending Phenomenon / 369
- 12.5 System Reliability / 371
- 12.6 Microwave Antennas / 376

Chapter 13. System Evaluations	381
<hr/>	
13.1 Performance Evaluation / 381	
13.2 Signaling Evaluation / 388	
13.3 Measurement of Average Received Level and Level Crossings / 395	
13.4 Spectrum Efficiency Evaluation / 404	
13.5 Portable Units / 417	
13.6 Evaluation of Data Modem / 423	
Chapter 14. Introduction to Digital Systems	427
<hr/>	
14.1 Why Digital? / 427	
14.2 Introduction to Digital Technology / 430	
14.3 ARQ Techniques / 440	
14.4 Digital Speech / 447	
14.5 Digital Mobile Telephony / 451	
14.6 Practical Multiple-Access Schemes / 454	
Chapter 15. Digital Cellular Systems	463
<hr/>	
15.1 Global System for Mobile (GSM) / 463	
15.2 North American TDMA / 486	
15.3 CDMA / 503	
15.4 Miscellaneous Mobile Systems / 533	
Chapter 16. Intelligent Cell Concept and Applications	563
<hr/>	
16.1 Intelligent Cell Concept / 563	
16.2 Applications of Intelligent Microcell Systems / 582	
16.3 In-building Communication / 594	
16.4 CDMA Cellular Radio Network / 601	
Chapter 17. Intelligent Network for Wireless Communications	617
<hr/>	
17.1 Advanced Intelligent Network (AIN) / 617	
17.2 SS7 Network and ISDN for AIN / 620	
17.3 AIN for Mobile Communication / 624	
17.4 Asynchronous Transfer Mode (ATM) Technology / 625	
17.5 An Intelligent System: Future Public Land Mobile Telecommunication System (FPLMTS) / 631	
17.6 Wireless Information Superhighway / 632	
Chapter 18. Cellular Related Topics	639
<hr/>	
18.1 Study of a 60-GHz Cellular System / 639	
18.2 Cellular Fixed Stations / 642	
18.3 Cellular Systems in Rural Service Areas / 645	
18.4 Diversity Media System with Millimeter-Wave Link and Optical-Wave Link / 646	
18.5 Cellular Radio Telecommunications Intersystem Operations / 650	