

- Foreword p. xi
- Preface p. xiii
- Acknowledgments p. xv
- Introduction p. 1
- 1 Fundamentals p. 15
- 1.1 Radio Channel Characteristics p. 15
- 1.1.1 Understanding Radio Channels p. 15
- 1.1.2 Channel Modeling p. 16
- 1.1.3 Channel Fade Statistics p. 18
- 1.1.4 Inter-Symbol (ISI) and Inter-Channel Interference (ICI) p. 19
- 1.1.5 Examples of Discrete Multipath Channel Models p. 20
- 1.1.6 Multi-Carrier Channel Modeling p. 21
- 1.1.7 Diversity p. 22
- 1.2 Multi-Carrier Transmission p. 24
- 1.2.1 Orthogonal Frequency Division Multiplexing (OFDM) p. 25
- 1.2.2 Advantages and Drawbacks of OFDM p. 30
- 1.2.3 Applications and Standards p. 30
- 1.3 Spread Spectrum Techniques p. 30
- 1.3.1 Direct Sequence Code Division Multiple Access p. 34
- 1.3.2 Advantages and Drawbacks of DS-CDMA p. 37
- 1.3.3 Applications of Spread Spectrum p. 37
- 1.4 Multi-Carrier Spread Spectrum p. 41
- 1.4.1 Principle of Various Schemes p. 41
- 1.4.2 Advantages and Drawbacks p. 43
- 1.4.3 Examples of Future Application Areas p. 44
- 1.5 References p. 45
- 2 MC-CDMA and MC-DS-CDMA p. 49
- 2.1 MC-CDMA p. 49
- 2.1.1 Signal Structure p. 49
- 2.1.2 Downlink Signal p. 50
- 2.1.3 Uplink Signal p. 51
- 2.1.4 Spreading Techniques p. 51
- 2.1.5 Detection Techniques p. 57
- 2.1.6 Pre-Equalization p. 65
- 2.1.7 Soft Channel Decoding p. 67
- 2.1.8 Flexibility in System Design p. 72
- 2.1.9 Performance Analysis p. 74
- 2.2 MC-DS-CDMA p. 83
- 2.2.1 Signal Structure p. 83
- 2.2.2 Downlink Signal p. 86
- 2.2.3 Uplink Signal p. 86
- 2.2.4 Spreading p. 86
- 2.2.5 Detection Techniques p. 87
- 2.2.6 Performance Analysis p. 87

- 2.3 References p. 90
- 3 Hybrid Multiple Access Schemes p. 93
  - 3.1 Introduction p. 93
  - 3.2 Multi-Carrier FDMA p. 94
    - 3.2.1 Orthogonal Frequency Division Multiple Access (OFDMA) p. 95
    - 3.2.2 OFDMA with Code Division Multiplexing: SS-MC-MA p. 100
    - 3.2.3 Interleaved FDMA (IFDMA) p. 104
  - 3.3 Multi-Carrier TDMA p. 105
  - 3.4 Ultra Wide Band Systems p. 107
    - 3.4.1 Pseudo-Random PPM UWB Signal Generation p. 107
    - 3.4.2 UWB Transmission Schemes p. 109
  - 3.5 Comparison of Hybrid Multiple Access Schemes p. 110
  - 3.6 References p. 112
- 4 Implementation Issues p. 115
  - 4.1 Multi-Carrier Modulation and Demodulation p. 116
    - 4.1.1 Pulse Shaping in OFDM p. 119
    - 4.1.2 Digital Implementation of OFDM p. 119
    - 4.1.3 Virtual Sub-Carriers and DC Sub-Carrier p. 120
    - 4.1.4 D/A and A/D Conversion, I/Q Generation p. 120
  - 4.2 Synchronization p. 123
    - 4.2.1 General p. 125
    - 4.2.2 Effects of Synchronization Errors p. 126
    - 4.2.3 Maximum Likelihood Parameter Estimation p. 129
    - 4.2.4 Time Synchronization p. 132
    - 4.2.5 Frequency Synchronization p. 136
    - 4.2.6 Automatic Gain Control (AGC) p. 139
  - 4.3 Channel Estimation p. 139
    - 4.3.1 Two-Dimensional Channel Estimation p. 140
    - 4.3.2 One-Dimensional Channel Estimation p. 143
    - 4.3.3 Filter Design p. 144
    - 4.3.4 Implementation Issues p. 145
    - 4.3.5 Performance Analysis p. 147
    - 4.3.6 Time Domain Channel Estimation p. 151
    - 4.3.7 Decision Directed Channel Estimation p. 152
    - 4.3.8 Blind and Semi-Blind Channel Estimation p. 153
    - 4.3.9 Channel Estimation in MC-SS Systems p. 154
    - 4.3.10 Channel Estimation in MIMO-OFDM Systems p. 158
  - 4.4 Channel Coding and Decoding p. 158
    - 4.4.1 Punctured Convolutional Coding p. 159
    - 4.4.2 Concatenated Convolutional and Reed-Solomon Coding p. 159
    - 4.4.3 Turbo Coding p. 162
    - 4.4.4 OFDM with Code Division Multiplexing: OFDM-CDM p. 166
  - 4.5 Signal Constellation, Mapping, Demapping, and Equalization p. 167
    - 4.5.1 Signal Constellation and Mapping p. 167

- 4.5.2 Equalization and Demapping p. 169
- 4.6 Adaptive Techniques in Multi-Carrier Transmission p. 170
- 4.6.1 Nulling of Weak Sub-Carriers p. 171
- 4.6.2 Adaptive Channel Coding and Modulation p. 171
- 4.6.3 Adaptive Power Control p. 172
- 4.7 RF Issues p. 172
- 4.7.1 Phase Noise p. 173
- 4.7.2 Non-Linearities p. 177
- 4.7.3 Narrowband Interference Rejection in MC-CDMA p. 185
- 4.7.4 Link Budget Evaluation p. 188
- 4.8 References p. 189
- 5 Applications p. 195
- 5.1 Introduction p. 195
- 5.2 Cellular Mobile Communications Beyond 3G p. 198
- 5.2.1 Objectives p. 198
- 5.2.2 Network Topology and Basic Concept p. 199
- 5.2.3 System Parameters p. 200
- 5.3 Wireless Local Area Networks p. 203
- 5.3.1 Network Topology p. 205
- 5.3.2 Channel Characteristics p. 206
- 5.3.3 IEEE 802.11a, HIPERLAN/2, and MMAC p. 206
- 5.3.4 Transmission Performance p. 208
- 5.4 Fixed Wireless Access below 10 GHz p. 210
- 5.4.1 Network Topology p. 211
- 5.4.2 Channel Characteristics p. 212
- 5.4.3 Multi-Carrier Transmission Schemes p. 212
- 5.4.4 Transmission Performance p. 220
- 5.5 Interaction Channel for DVB-T: DVB-RCT p. 220
- 5.5.1 Network Topology p. 221
- 5.5.2 Channel Characteristics p. 223
- 5.5.3 Multi-Carrier Uplink Transmission p. 223
- 5.5.4 Transmission Performance p. 229
- 5.6 References p. 230
- 6 Additional Techniques for Capacity and Flexibility Enhancement p. 233
- 6.1 Introduction p. 233
- 6.2 General Principle of Multiple Antenna Diversity p. 234
- 6.2.1 BLAST Architecture p. 235
- 6.2.2 Space-Time Coding p. 236
- 6.2.3 Achievable Capacity p. 239
- 6.3 Diversity Techniques for Multi-Carrier Transmission p. 240
- 6.3.1 Transmit Diversity p. 240
- 6.3.2 Receive Diversity p. 244
- 6.3.3 Performance Analysis p. 245
- 6.3.4 OFDM and MC-CDMA with Space-Frequency Coding p. 248

- 6.4 Examples of Applications of Diversity Techniques p. 253
- 6.4.1 UMTS-WCDMA p. 253
- 6.4.2 FWA Multi-Carrier Systems p. 254
- 6.5 Software-Defined Radio p. 255
- 6.5.1 General p. 255
- 6.5.2 Basic Concept p. 257
- 6.5.3 MC-CDMA-Based Software-Defined Radio p. 258
- References p. 260
- Definitions, Abbreviations, and Symbols p. 263
- Definitions p. 263
- Abbreviations p. 265
- Symbols p. 270
- Index p. 275