## Contents

**Preface**

1. **Evolution from 2G over 3G to 4G**
   1.1 First Half of the 1990s — Voice-Centric Communication .......................... 1
   1.2 Between 1995 and 2000: The Rise of Mobility and the Internet ................. 1
   1.3 Between 2000 and 2005: Dot Com Burst, Web 2.0, Mobile Internet ............ 2
   1.4 Between 2005 and 2010: Global Coverage, Fixed Line VoIP, and Mobile Broadband .......................... 4
   1.5 2010 and Beyond ................................................................................. 5
   1.6 All over IP in Mobile — The Biggest Challenge .................................. 6
   1.7 Summary ............................................................................................... 6

2. **Beyond 3G Network Architectures**
   2.1 Overview .............................................................................................. 9
   2.2 UMTS, HSPA, and HSPA+ ............................................................... 10
      2.2.1 Introduction .................................................................................... 10
      2.2.2 Network Architecture ................................................................... 10
      2.2.3 Air Interface and Radio Network .................................................. 19
      2.2.4 HSPA (HSDPA and HSUPA) ......................................................... 28
      2.2.5 HSPA+ and other Improvements: Competition for LTE .................. 34
      2.2.6 Competition for LTE in 5 MHz .................................................... 43
   2.3 LTE ...................................................................................................... 43
      2.3.1 Introduction .................................................................................... 43
      2.3.2 Network Architecture ................................................................... 44
      2.3.3 Air Interface and Radio Network .................................................. 49
      2.3.4 Basic Procedures ......................................................................... 64
      2.3.5 Summary and Comparison with HSPA ........................................ 67
      2.3.6 LTE-Advanced ............................................................................. 68
   2.4 802.11 Wi-Fi ....................................................................................... 74
      2.4.1 Introduction .................................................................................... 74
      2.4.2 Network Architecture ................................................................... 76
      2.4.3 The Air Interface — From 802.11b to 802.11n .............................. 78
      2.4.4 Air Interface and Resource Management ....................................... 83
2.4.5 Basic Procedures
2.4.6 Wi-Fi Security
2.4.7 Quality of Service: 802.11e
2.4.8 Gigabit Speeds with 802.11ac and 802.11ad
2.4.9 Summary

3 Network Capacity and Usage Scenarios
3.1 Usage in Developed Markets and Emerging Economies
3.2 How to Control Mobile Usage
   3.2.1 Per Minute Charging
   3.2.2 Volume Charging
   3.2.3 Split Charging
   3.2.4 Small Screen Flat Rates
   3.2.5 Strategies to Inform Users when their Subscribed Data Volume is Used Up
   3.2.6 Mobile Internet Access and Prepaid
3.3 Measuring Mobile Usage from a Financial Point of View
3.4 Cell Capacity in Downlink
3.5 Current and Future Frequency Bands for Cellular Wireless
3.6 Cell Capacity in Uplink
3.7 Per-User Throughput in Downlink
3.8 Per-User Throughput in Uplink
3.9 Traffic Estimation Per User
3.10 Overall Wireless Network Capacity
3.11 Network Capacity for Train Routes, Highways, and Remote Areas
3.12 When will GSM be Switched Off?
3.13 Cellular Network VoIP Capacity
3.14 Wi-Fi VoIP Capacity
3.15 Wi-Fi and Interference
3.16 Wi-Fi Capacity in Combination with DSL, Cable, and Fiber
3.17 Backhaul for Wireless Networks
3.18 A Hybrid Cellular/Wi-Fi Network Today and in the Future

4 Voice over Wireless
4.1 Circuit-Switched Mobile Voice Telephony
   4.1.1 Circuit Switching
   4.1.2 A Voice-Optimized Radio Network
   4.1.3 The Pros of Circuit Switching
   4.1.4 TheBearer Independent Core Network Architecture
4.2 Packet-Switched Voice Telephony
   4.2.1 Network and Applications are Separate in Packet-Switched Networks
   4.2.2 Wireless Network Architecture for Transporting IP Packets
   4.2.3 Benefits of Migrating Voice Telephony to IP
   4.2.4 Voice Telephony Evolution and Service Integration
   4.2.5 Voice Telephony over IP: The End of the Operator Monopoly
6.3 Web 2.0 — Empowering the User 299
6.4 Web 2.0 from the User’s Point of View 299
  6.4.1 Blogs 300
  6.4.2 Media Sharing 300
  6.4.3 Podcasting 300
  6.4.4 Advanced Search 301
  6.4.5 User Recommendation 302
  6.4.6 Wikis — Collective Writing 302
  6.4.7 Social Networking Sites 303
  6.4.8 Web Applications 304
  6.4.9 Mashups 304
  6.4.10 Virtual Worlds 305
  6.4.11 Long-Tail Economics 305
6.5 The Ideas behind Web 2.0 306
  6.5.1 The Web as a Platform 306
  6.5.2 Harnessing Collective Intelligence 306
  6.5.3 Data is the next Intel Inside 307
  6.5.4 End of the Software Release Cycle 308
  6.5.5 Lightweight Programing Models 308
  6.5.6 Software above the Level of a Single Device 309
  6.5.7 Rich User Experience 309
6.6 Discovering the Fabrics of Web 2.0 310
  6.6.1 HTML 310
  6.6.2 AJAX 311
  6.6.3 Aggregation 314
  6.6.4 Tagging and Folksonomy 316
  6.6.5 Open Application Programing Interfaces 318
  6.6.6 Open Source 320
6.7 Mobile Web 2.0 — Evolution and Revolution of Web 2.0 321
  6.7.1 The Seven Principles of Web 2.0 in the Mobile World 322
  6.7.2 Advantages of Connected Mobile Devices 325
  6.7.3 Access to Local Resources for Web Apps 328
  6.7.4 2D Barcodes and Near Field Communication (NFC) 329
  6.7.5 Web Page Adaptation for Mobile Devices 330
6.8 (Mobile) Web 2.0 and Privacy and Security Considerations 334
  6.8.1 On-Page Cookies 334
  6.8.2 Inter-Site Cookies 336
  6.8.3 Flash Shared Objects 336
  6.8.4 Session Tracking 337
  6.8.5 HTML5 Security and Privacy Considerations 338
  6.8.6 Private Information and Personal Data in the Cloud 338
6.9 Mobile Apps 340
  6.9.1 App Stores and Ecosystem Approaches 341
6.10 Android App Programing Introduction 342
  6.10.1 The Eclipse Programing Environment 342
  6.10.2 Android and Object Oriented Programing 342