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978-0-521-76870-2 - Essentials of LTE and LTE-A
Amitabha Ghosh and Rapeepat Ratasuk
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Essentials of LTE and LTE-A

This practical, one-stop guide will quickly bring you up-to-speed on LTE and LTE-Advanced (LTE-A). With everything you need to know about the theory and technology behind the standards, this is a must-have for engineers and managers in the wireless industry.

- First book of its kind describing technologies and system performance of LTE-A
- Covers the evolution of digital wireless technology, basics of LTE and LTE-A, design of downlink and uplink channels, multi-antenna techniques, and heterogeneous networks
- Analyzes performance benefits over competing technologies, including WiMAX and 802.16m
- Reflects the latest LTE Release-10 standards
- Includes numerous examples, including extensive system and link results
- Unique approach is accessible to technical and non-technical readers alike

AMITABHA GHOSH is a Senior Director and Fellow of the Technical Staff at Motorola Solutions, where he works in the area of current and future air-interface technologies for 802.16m, 3GPP LTE, LTE-Advanced, and other broadband technologies. Since joining Motorola, he has worked on eight different wireless technologies, and is currently leading Motorola's efforts in defining 3GPP LTE and LTE-Advanced physical layer standards from the concept phase to the adopted baseline.

RAPEEPAT RATASUK is currently a Distinguished Member of the Technical Staff at Motorola Solutions. He has extensive experience in 3G/4G cellular system design and analysis (specifically LTE, HSPA, WiMAX, 1xEV-DV, and W-CDMA technologies), including algorithm development, performance analysis and validation, physical layer modeling, and simulations.

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To my parents for their continuous support and teaching me the value of education and thirst for knowledge; and to my family, Chittarupa, Devika, and Adit, for their support, encouragement, and love.

Amitabha Ghosh

To Tanita, Alisa, and Paul.

Rapeepat Ratasuk

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Preface

The next-generation wireless broadband technology is changing the way we work, live, learn, and communicate through effective use of state-of-the-art mobile broadband technology. The packet-data-based revolution started around 2000 with the introduction of 1x Evolved Data Only (1xEV-DO) and 1x Evolved Data Voice (1xEV-DV) in 3GPP2 and High Speed Downlink Packet Access (HSDPA) in 3GPP. The wireless broadband fourth-generation technology (4G) is an evolution of the packet-based 3G system and provides a comprehensive evolution of the Universal Mobile Telecommunications System specifications so as to remain competitive with other broadband systems such as 802.16e (WiMAX). Specification work was started in late 2004 on Long Term Evolution (LTE) of the UMTS Terrestrial Radio Access and Radio Access Network intended for commercial deployment in 2010. Two main components constitute the LTE system architecture – the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and the Evolved Packet Core (EPC). The goals for the evolved system (E-UTRAN and EPC) included support for improved system capacity and coverage, high peak data rates, low latency, reduced operating costs, multi-antenna support, flexible bandwidth operations, and seamless integration with existing systems. The standardization work for LTE Rel-8 was completed in early 2009 and commercial LTE systems will be deployed in the 2011–2012 timeframe. LTE Rel-8 is currently evolving to LTE-Advanced (LTE Rel-9 and Rel-10), which will further improve the spectral efficiency, peak rates, and user experience compared with LTE Rel-8. LTE-Advanced has also been approved by the International Telecommunication Union (ITU) as an International Mobile Telecommunications-Advanced (IMT-A) technology.

The book is organized in seven chapters. Chapter 1 gives a timeline and brief description of the evolution of digital wireless technology starting with GSM, IS-95, cdma2000 1x, WCDMA Rel-99, HSPA (Rel-5/6),

WiMAX, LTE, LTE-Advanced, and 802.16m with emphasis on how supported data rates, throughput, and applications have evolved. Chapter 2 provides a brief description of LTE requirements and system architecture together with the basic principles of orthogonal frequency-division multiple-access (OFDMA) and single-carrier frequency-division multiple-access (SC-FDMA) technology. Chapter 3 dives into the basic details of LTE downlink OFDMA transmission including transport and physical-channel structure, control-channel details, system operations, and inter-cell interference coordination schemes both for FDD (Frequency-Division Duplex) and for TDD (Time-Division Duplex) LTE. Aspects of downlink system performance under various channels and antenna structure are summarized at the end of the chapter.

Chapter 4 provides the details of LTE uplink transport and physical-channel structure, control-channel details, random access, system operations, and fractional power control followed by uplink system performance under various channels and antenna configurations. The LTE system offers a rich suite of multiple-antenna techniques that can be used in various scenarios to improve the performance and user experience. Chapter 5 describes various multi-antenna schemes for LTE downlink and uplink and provides a system-performance comparison of various multi-antenna schemes. Chapter 6 is devoted to technologies for LTE-Advanced (LTE-A). The chapter describes the requirements for IMT-A and how LTE-A will satisfy those requirements using enhanced technologies. The technologies include support of wider bandwidth using carrier aggregation, uplink spatial multiplexing, enhanced downlink spatial multiplexing, coordinated multiple-point transmission and reception, and heterogeneous networks including relays, distributed antenna systems, and pico-cells. Aspects of the system performance of these enhancements are presented and compared with the performance of the legacy LTE system.

Finally, Chapter 7 provides a comparison of LTE/LTE-A with other competitive broadband systems such as 802.16e/802.16m. As the name signifies, this chapter outlines both qualitative and quantitative differences between the 802.16e/802.16m (WiMAX) system and the LTE/LTE-A system. System performance comparisons between these systems are presented for various reuse schemes and antenna configurations.

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At the time of writing, there are ongoing discussions within the operator and vendor community regarding further evolution of LTE-A technology. These enhancements will appear in Rel-11 and Rel-12 of 3GPP and will offer better user experience, lower cost per bit, greener base stations, and efficient self-organizing networks.

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