Chapter 17
Long-Term Evolution (LTE): Broadband-Enabled Next Generation of Wireless Mobile Cellular Network

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ABSTRACT

With the ever growing demand on high throughput for mobile users, 3G cellular networks are limited in their network capacity for offering high data services to a large number of users. Consequently, many Internet services such as on-demand video and mobile TV are hard to be satisfactorily supported by the current 3G cellular networks. 3GPP Long Term Evolution (LTE) is a recently proposed 4G standard, representing a significant advance of 3G cellular technology. Attractively, LTE would offer an uplink data speed up to 50 Mbps and a downlink speed up to 100 Mbps for various services such as traditional voice, high-speed data, multimedia unicast, and multimedia broadcasting. In such a short time, it has been broadly accepted by major wireless vendors such as Verizon-Vodafone, AT&T, NTT-Docomo, KDDI, T-Mobile, and China Mobile. In order for high data link speed, LTE adapts new technologies that are new to 3G network such as Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input Multiple-Output (MIMO). MIMO allows the use of more than one antenna at the transmitter and receiver for higher data transmission. The LTE bandwidth can be scalable from 1.25 to 20 MHz, satisfying the need of different network operators that may have different bandwidth allocations for services, based on its managed spectrum. In this chapter, we discuss the major advance of the LTE and its recent research efforts in improving its performance. Our illustration of LTE is comprehensive, spanning from the LTE physical layer to link layer. In addition, the LTE security is also discussed.

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INTRODUCTION

Long-Term Evolution (LTE)[3GPP TS 36.300) is a cellular network technology for mobile phone systems, which has a history of almost thirty years. The cellular network capacity can be defined as the average throughput (or data bit rate) per user which is the key issue in providing high quality services for users. It is well known that cellular network suffers from the limited network capacity, especially with the increase in the number of users in the network. This drives the cellular networks towards Broadband Wireless Access (BWA) such as LTE for providing high-speed wireless access over a wide area while satisfying the Quality of Service (QoS) requirement for a variety of services.

Figure 1 illustrates the milestones of cellular technologies from the second generation (2G) to the fourth generation (4G) and shows the increase of the network capacity. Before 2G, the first generation (1G) of cellular network is analog FDMA system, developed in the early of 1980. The use of digital modulation such as TDMA (Time Division Multiple Access) is the significant progress of the 2 generation (2G), as compared to 1G. GSM (Global System for Mobile Communications) is the most popular 2G system, representing the huge success of 2G. Most GSM networks (in Europe) operate in the 900 MHz or 1800 MHz bands. However, the 850 MHz and 1900 MHz bands were used in Canada and the United States. In the 2G mobile system, roaming and security are enhanced with the support of user handoff from a base station (BS) to a neighboring BS.

The 2G cellular system with the addition of General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE) is mostly referred as the 2.5G. The original GSM is limited by its network capacity and the per user data rate is scaled by several kbits/s. Upon the original GSM system, the packet data capability is added for packet-oriented mobile data service by means of GPRS in 1997. GPRS provides data rates of 56 kbit/s or more. In 1999, EDGE further improved the speed data transmission. EDGE is also known as Enhanced GPRS (EGPRS) and is first deployed on the GSM system in 2003. The Evolved EDGE typically offers bit-rates of 400kbit/s.

Figure 1. LTE evolution path