BP-2: The Long-term Evolution of 3G: Evolved UTRA and UTRAN

Fumiyuki Adachi (Graduate School of Engineering, Tohoku University)

Foreword

This is a special report of seven panel discussions sponsored by Communications Society in 2008 IEICE General Conference held in Kitakyusyu-shi, Japan in this March.

Hot topics related to advanced communication technologies were extensively discussed by the experts together with the participants to explore not only the future of communications technologies but also the deployment of new systems and services.

1. Introduction

In line with the recent explosive expansion of Internet traffic in the fixed networks, demand for a variety of broadband packed services has been becoming stronger even in cellular communication networks. The 3rd generation (3G) networks based on wideband direct-sequence code division multiple access (W-CDMA) technique [1] with much higher data rates up to 384kbps than the 2nd generation (2G) networks were introduced already in many countries and their deployment speed has since accelerated. High speed data services including e-mailing, Web browsing, and on-line services ranging from bank transactions to entertainment are now available over the 2G/3G networks. The 3G networks are continuously evolving with high speed downlink/uplink packet access (HSDPA/HSUPA) technique, multiple-input/multiple-output (MIMO) antenna technique, etc, for providing packet data services up to approximately 14Mbps as the mid-term evolution and 100Mbps as the long-term evolution (LTE) in the downlink.

The 3rd Generation Partnership Project (3GPP) has been working on the specification of the radio interface of the Evolved UMTS Terrestrial Radio Access (UTRA) and UMTS Terrestrial Radio Access Network (UTRAN) as the LTE of the 3G system. The standardization activity is now approaching its final phase. Evolved UTRA/UTRAN is an IP-based packet radio access with reduced latency, higher peak data rate, and higher frequency efficiency comparing to the HSDPA/HSUPA. It can offer the unified packet data services from voice to high-speed data transmission with lower lost. In this panel, Evolved UTRA/UTRAN and radio access technologies for the Evolved UTRA as well as future IMT-Advanced will be discussed.

This panel session [2] was organized by **Prof. Adachi** with a generous help from Prof. Mamoru Sawahahi (Musashi Institute of Technology). In this panel session, five panelists who have been actively contributing to the evolution of radio technology were invited. Among the panelists were Dr. Sadayuki Abeta (NTT DoCoMo), Prof. Yasutaka Ogawa (Hokkaido University), Dr. Akihisa Ushirokawa (NEC Corporation), Dr. Katsuhiko Hiramatsu (Matsushita Electric Industrial Co.) and myself (Prof. Fumiyuki Adachi (Tohoku University)). More than 100 audiences participated from universities and wireless industry in this panel session.

2. Presentation and Discussion

First, five panelists presented their views on Evolved UTRA/UTRAN technologies. The first speaker was **Dr. Abeta,** who overviewed the specification of the Evolved UTRA/UTRAN which is optimized for low delay broadband packet services. In Evolved UTRA, different access techniques are adopted: orthogonal frequency division multiple access (OFDMA) for the downlink and single-carrier (SC)-FDMA using frequency-domain equalization (FDE) for the uplink. The target data rate is as high as 50Mbps (uplink) and 100Mbps (downlink) using 20MHz bandwidth allocated as the 3G spectrum. High user-throughput is achieved particularly at the cell edge. The delay requirement is much shorter than 3G networks and is 5ms one-way within RAN for the user plane (U-plane) and 100ms in the idle-to-active mode for the control plane (C-plane). Also he briefly introduced the radio access network architecture and protocols.

The next speaker was myself (**Prof. Adachi**) and introduced the fundamentals of OFDMA, SC-FDMA, FDE, hybrid ARQ, and packet scheduling, whose are designed for the LTE radio access technique. The LTE uses the 3G spectrum whose bandwidth is only 20MHz per system. One of most important radio techniques is MIMO space division multiplexing (SDM) to meet a challenging target of 100Mbps using 20MHz bandwidth. Prof. Ogawa was the third speaker who introduced the fundamentals of MIMO SDM based on precoding matrix selection. 2-by-2 and 4-by-4 MIMO SDMA can achieve 150Mbps and 300Mbps, which are higher than the LTE downlink target. Also important is MIMO antenna diversity to improve the communication quality. Prof. Ogawa also introduced the space-frequency block coding (SFBC) based on the famous Alamouti's space-time block coding (STBC).

Dr. Ushirokawa introduced the major requirement and configuration of the Evolved UTRAN. Important is to reduce the delay both in the U- and C-planes for providing user friendly/flexible broadband services. The delay requirement can be realized by reduced packet frame size (1ms), simplified protocols, and

©2008, IEICE

placement of MAC, RLC, RRC and RRM functionalities at evolved Node-B (eNB). This placement allows a simple and flat RAN architecture with eNBs only, i.e. without Radio Network Controllers (RNCs) in Evolved UTRAN. Also presented by Dr. Ushirokawa was the Evolved Packet System structure, which allows a smooth migration from 3G UTRAN into Evolved UTRAN and further into the radio access network of IMT-Advanced called 4G networks.

Final speaker was **Dr. Hiramatsu**, who introduced the configurations of LTE base station (i.e., eNB) and user equipments (UEs) in detail and also foreseeable broadband services. A variety of services will be available by the LTE networks. Some example services are broadband Web browsing, File Transfer Protocol (FTP), video streaming, and Multimedia Broadcast and Multicast Service (MBMS).

After presentation by five panelists, panelists and participants discussed about how Evolved UTRA/UTRAN is different from other wireless networks: W-CDMA, HSDPA/HSUPA, and WiMAX, etc., from technology and services point of view.

3. Conclusion

In this panel session, the technologies of evolved 3G networks designed for optimizing packet data services using 3G spectrum were introduced and discussed. The capabilities of 3G networks will sooner or later be insufficient to cope with the increasing demands for broadband services. The evolved 3G networks will be followed by the development of 4G, i.e., IMT-Advanced networks, that support extremely broadband packet data services of e.g., 100M~1Gbps [3].

4. Reference

[1] F. Adachi, M. Sawahashi, and H. Suda, "Wideband DS-CDMA for next generation mobile communications systems," IEEE Commun. Mag., vol. 36, no. 9, pp. 56-69, Sept. 1998.

[2] "The long-term evolution of 3G:Evolved UTRA and UTRAN," The 2008 IEICE General Conference, BP-2-1~5, Kitakyusyu Science and Research Park, 20 March, 2000.

[3] Y. Kim, et al., "Beyond 3G: vision, requirements, and enabling technologies," IEEE Commun. Mag., Vol. 41, No. 3, pp.120-124, Mar. 2003.

Organizer of the Panel

BP-2: Prof. Fumiyuki ADACHI
Graduate School of Engineering, Tohoku University

©2008, IEICE