Introduction of 4G Activities in Korea

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***Abstract*— In Korea, the development of 4G mobile system technologies is very actively carried on. The activities of 4G development in Korea will be introduced in this paper. In the first part, the current status of preparing the commercial WiBro service will be presented. The WiBro Service (Portable Internet Service for 2.3GHz), as the low mobility data service, has been defined as a pre-4G service and the development of the system for 30 ~ 50Mbps is on the way for deploying the commercial service in 2006. In the second part, the direction of the technology development for the 4G mobile system will be introduced. The 4G system will support 100Mbps data rate for high mobility and 1Gbps for low mobility based on the ITU-R recommendation. In the last part, various collaborative activities in Asia area, such as the NGMC forum in Korea and CJK collaboration, will be introduced in the paper.**

I. INTRODUCTION

Korea is one of the world's most concentrated markets for high-speed Internet connections. There are also about 36.6 million mobile phones users, or 75 percent of the population. Broadband service providers have recently been hit by slow growth, saturation in the market and weak consumption caused by an economic downturn that has put the emphasis on the need for new services. We hope the WiBro service would create a new source of revenue for the country's saturated fixed-line and mobile telecommunication markets.

Mobile communications have evolved from the first generation analog system to the second generation systems such as code division multiple access (CDMA) [1], [2] and global system for mobile (GSM). Now the third generation (3G) International Mobile Telecommunication-2000 (IMT-2000) has begun to provide a variety of services with almost the same quality as integrated service digital network (ISDN) services provided in the wired-network realm. Despite the delay in the commercialization of IMT-2000 services due to the worldwide economic recession, the next generation mobile communications and services are being watched with keen interest.

The next-generation (NG) mobile communication, the so called fourth generation (4G), is a system that is able to provide a variety of multimedia services such as multimedia moving pictures, movies, and television broadcasts with high-speed and high quality via the converged network of wireless and wired infrastructures. Thus, a variety of video, audio, and data services will be possible with a number of service classes in addition to the conventional mobile services such as voice telephony. These include mobility based services such as information services based on location of the user and an emergency call service that can send pictures and/or the location of the user. Besides, there are many services still to be discovered and created. To provide above new mobile services, 4G system is required to support 100 Mbps data rate for high mobility and 1Gbps for low mobility. Currently, the HMm testbed is being developed as a pilot research testbed to investigate feasibility of the derived next generation mobile services.

This paper is organized as follows. In the next section, we describe the WiBro system which is the official name for the portable Internet system standard in Korea. In section 3, we introduce R&D strategies for the next generation mobile systems in Korea, and the High-speed Mobile Multimedia (HMm) system as an example of research activities. In section 4, we propose a conceptual reference network architecture which is designed to support these services by placing network functions and service elements on different network parts. Finally, we briefly introduce research and development activities and strategies for NG mobile communication system and services in Korea [3].

II. THE WIBRO SYSTEM AND ITS SERVICES

The WiBro system, an official name of portable Internet system in Korea and a stepping stone toward fourth-generation mobile communications, is ready to launching its services in 2006. The WiBro is a homegrown variant standard of IEEE802.16e which has, apparently, now been folded into WiMAX so there will be international harmonization. It's expected to cost about $30 a month for getting Wibro services. Current portable Internet specification is mainly based on IEEE802.16 [4] with additionally requests to support TDD mode and the seamless service over 60 km/h. TDD system has been proved to provide a good solution for high-speed packet transmission which has the specific features such as the discontinuous data transmission and the traffic asymmetry between uplink and downlink. Due to the spectral efficiency and the robustness against the inter-symbol interference (ISI) and multi-path fading, OFDM is also considered as an effective technique in high speed digital communication systems. In addition, it is shown that OFDM/TDMA TDD systems offer good performance [5]. ETRI is developing the WiBro system not only to overcome drawbacks of the wireless LAN system such as small coverage and radio interference but also to accommodate increasing demand for

portable Internet access under low or medium mobility via various user terminals such as portable PC, PDA, and so on. The WiBro system is considered as the first system that bridges the wired and wireless realm by giving portable Internet access.

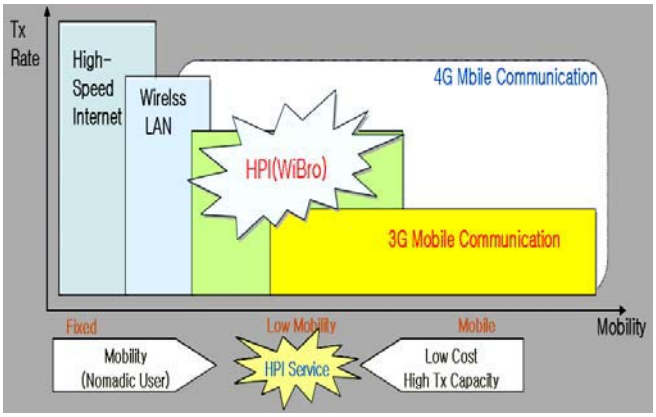

Fig. 1. Position of WiBro in wireless communication

It is designed to provide seamless mobile connectivity over the 2.3GHz spectrum at ground speeds up to 60 kilometers per hour with an average bandwidth of 1Mbps. The downstream speed is about 10 times faster than the current mobile connection to the network via cell phone based on the CDMA 1x EV-DO (evolution data optimized) technology. This means people will be able to savor the benefits of Internet on the move at a speed similar to the current fixed-line broadband with the advent of WiBro. It will deliver mobility with the high speed and cost-effectiveness of an all-IP, all-packetized data system, offering users things like streaming video and music, video and music on demand, online gaming, broadcasting and VoIP.

TABLE I
BASIC REQUIREMENTS OF WIBRO SYSTEM

Category	Items	Development Contents
Low cost	. High transmission efficiency . Broad bandwidth . lots of users(active/dormant)	. OFDM, AMC, H-ARQ . 10MHz BW . Bandwidth Allocation
High speed transmission	. Sector/User throughput . Cell capacity . MAC & RRC.	. OFDM, OFDMA, SA/MIMO . 1 to 3 Sectors .Bandwidth Allocation,H-ARQ
Full Coverage	. Easy cell planning . Micro/Pico Cell	. Reuse factor = ~ 1 . Ranging for larger area
Mobility	. Longer battery usage . Seamless service	. Power saving mode . Handover
Multimedia Service	. Burst traffic . Session control	. Dynamic bandwidth allocation . Connection oriented

Characteristics of the WiBro system in terms of the data rate and mobility in wireless communications and requirements of the WiBro system are shown in Figure 1 and Table I respectively. Three Companies, KT Corporation, SK Telecom and Hanaro Telecom, have acquired privilege for WiBro services from the government in early 2005. Commercial service is expected to begin in 2006, but it will take another two years to cover all Korean cities. It is expected for each WiBro service provider to invest about $1 billion to build infrastructure. It is anticipated that there will be about 9.5 million WiBro subscribers around 2012.

Phase 1 WiBro system, also called the High-speed Portable Internet (HPi) system, is under developing at ETRI based on system requirements. Figure 2 describes network architecture of the WiBro system. In the WiBro architecture, users are connected to the WiBro system through access point (AP). Then a group of APs are managed by the packet access router (PAR). PARs are connected to the IP based networks. Required functions of the PAR are user authentication (AAA), FA control of MIP, diameter based protocol (DBP) processing for communication between MIP nodes, interface protocol processing for interconnection with AP, address processing and management, handoff processing, accounting, basic call processing, user database management, QoS management, and management of PAR initialization and OAM [6].

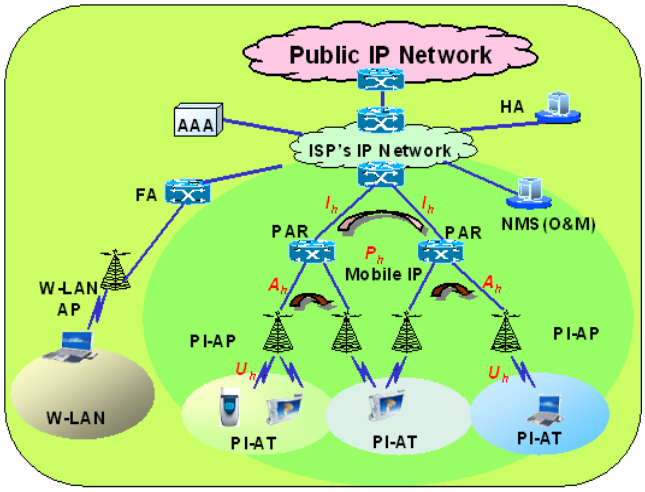

Fig. 2. Network architecture of WiBro/HPi (Phase 1)

III. THE HIGH-SPEED MOBILE MULTIMEDIA (HMM) SYSTEM

It is expected that the standardization for beyond 3G mobile system will take concrete shape after 2007. Hence the standardization process for beyond 3G mobile system will be a de facto standardization process in which a system is developed and commercialized before standardization. Therefore, ETRI is developing basic unit core technologies for beyond 3G mobile system not only for co-existence with the IMT-2000 system in the high speed packet data market, but also for taking initiative on standardization and development of the system.

With related to these activities on standardization and system development of beyond 3G mobile communications, ETRI is developing the HMm testbed as a pilot research testbed for investigating feasibility of the derived next generation mobile services under the proposed conceptual reference network architecture shown in figure 3.

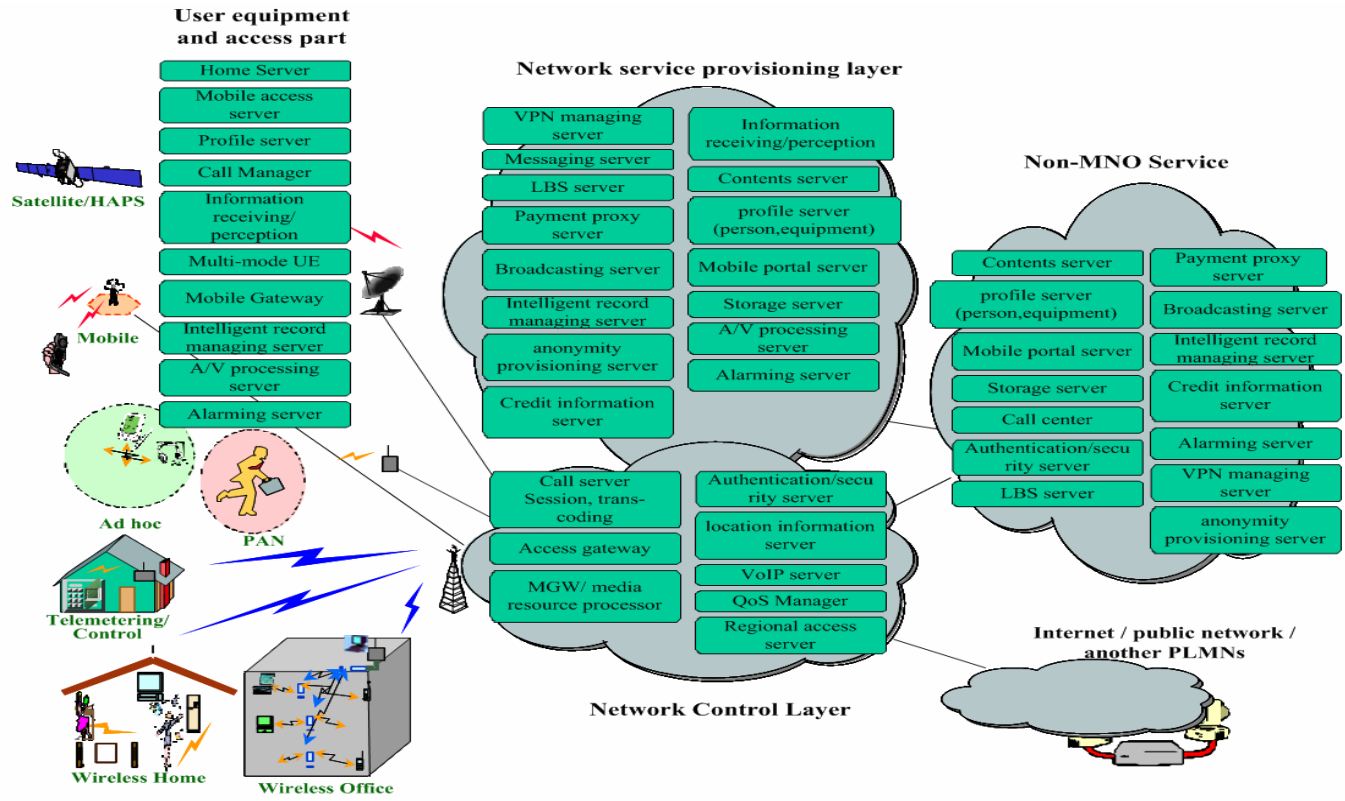

Fig. 3. A conceptual reference network architecture that is capable to provide the next generation mobile

TABLE II
SYSTEM REQUIREMENTS AND CHARACTERISTICS OF THE HMM TESTBED SYSTEM

Items	Target requirements
Spectrum	2GHz or 3 _ 5GHz
Channel	Asymmetric band/carrier • Downlink: 5_20 MHz, Uplink: 5MHz
Multiplexing	OFDM-FDMA / FDD / frequency-hopping
Service type	packet based
Cell	Macro, micro (Hot spot)
Transmission rate	100Mbps (peak aggregate payload/cell)

The HMm testbed system is designed to support at most 100 Mbps transmission rate at 60km/h using 20MHz bandwidth at 2GHz or 3_5GHz. In addition, the HMm system will be able to support high mobility up to 250km/h. The HMm testbed system (version 1.0) will be developed by 2005. Table II shows system requirements and characteristics of the HMm system.

I. THE PROPOSED REFERENCE NETWORK ARCHITECTURE MOBILE MULTIMEDIA (HMM) SYSTEM

In this section, we propose a conceptual reference network architecture that is able to support the next generation mobile services derived in the scenario based research activities[7][1]. We designed the conceptual reference network architecture with focusing on the realization of the service technologies. By taking advantages of the results of the downward research, we find necessary hardware/software units, called *service elements*, such as a handset, servers, processors and gateways that should be placed in the network to support service technologies.

The proposed reference network consists of four different parts, *an user equipments and access part, a network service provisioning layer part, a network control layer part*, and *non-mobile network operator service part*.

The user equipments and access part represents functions and network configuration elements between user equipments and networks. Some network functions and service elements such as a home server, a mobile access server, a profile server for persons and equipments, a call manager, a multi-mode user equipment, a mobile gateway, an intelligent record managing server are need to be placed in this part to provide the next generation mobile services. *The network service provisioning layer part* represents functions and network configuration elements between the end of user equipments or access and the end of service provider's networks. Many network functions and service elements including an LBS server, a messaging server, a payment proxy server, a contents server, a mobile portal server and a storage server should be placed in this part.

The network control layer part is in charge of controlling the network service provisioning layer part. Thus, call servers

for session and trans-coding, an access gateway, a media gateway/media resource processor, an authentication and security server, an location information server, a VoIP server and a QoS managing server should be placed here.

Finally, *the non-mobile network operator service part* represents value-added functions and network configuration elements that are connected to a network service provisioning layer part by an operator other than service providers. Many different types of network functions and service elements such as a contents server, a profile server for person and equipments, a mobile portal server, a payment proxy server, a call center, and a storage server are placed in this part.

Figure 3 describes a conceptual reference network architecture proposed to support the next generation mobile services

II. R&D Activities in Korea for Beyond 3G Mobile Communications

1) R&D Strategies for B3G in Korea: Beyond 3G mobile communications including next generation mobile communications are being developed in Korea through a cooperative research work among various organizations including Electronics and telecommunications Research Institute (ETRI), universities, mobile service operators, and domestic manufacturers. This cooperative activity is led by ETRI with contributions from many participating organizations and collaborative work via international partnership. Goals of Korea's R&D activities on beyond 3G mobile communications are to take global leadership in wireless telecommunications, to achieve a 30 percent share of the world market, and to establish the world's first Broadband Convergence Network (BcN) based infrastructure that can unify wired, wireless and broadcasting systems.

In order to support such research activities and establish the vision and strategies of the mobile service beyond 3G, Korean 4G vision committee and NGMC (Next Generation Mobile Communication) Forum were organized in January 2002 and October 2003 respectively. In particular, NGMC Forum was organized due to increasing interests on beyond 3G mobile communication technologies and services as well as needs of an international organization for beyond 3G mobile communication research led by Korean organizations like WWRF, mITF, and FuTURE in other countries.

The objectives of the NGMC Forum are technical and social trends analysis, vision establishment, international cooperation, advanced research and development strategies, and study on spectrum use. Research and development strategies and activities for the next generation mobile communications in Korea is described in figure 4.

2) R&D Activities for B3G in Korea: ETRI is currently developing basic unit core technologies for beyond 3G mobile systems.

ETRI's current research activities are focused on development of the radio transmission technologies for beyond 3G mobile system defined as the Ubiquitous Broadband Mobile Access with Optimal Bandwidth and Cost. Requirements for achieving this goal are

- Improvement of frequency efficiency.
- Increase of the cell coverage.
- Lower data transmission cost based on quality of service (QoS) and differentiation of service classes.
- Establishment of packet-centric systems for all IP environments.
- Harmonization or convergence with existing systems such as 3G mobile system, wireless LAN and broadcasting systems

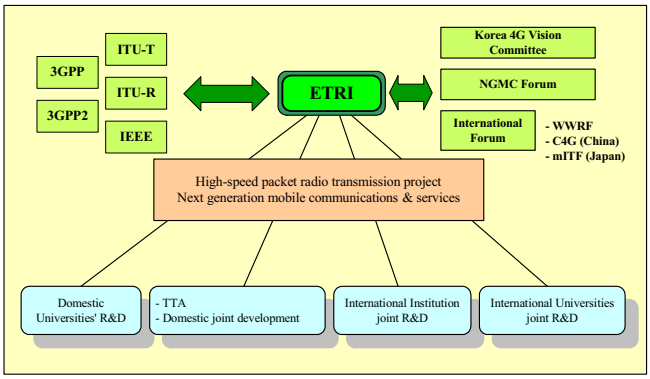

Fig. 4. Research and development strategies and activities for the next generation mobile communications in Korea.

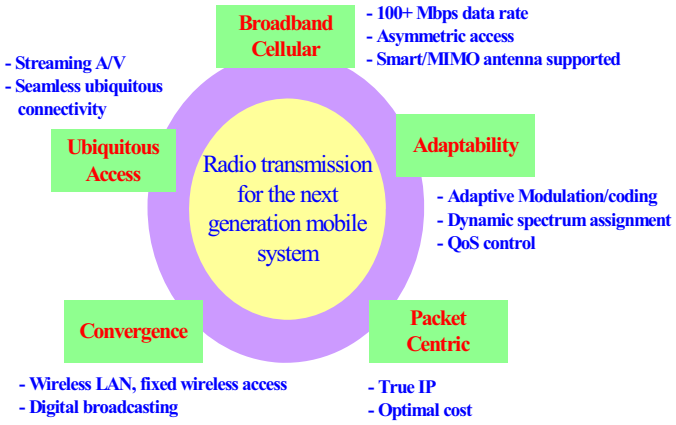

Fig. 5. The concept of ETRI's research activities on beyond 3G mobile radio transmission technologies.

Figure 5 shows the concept of ETRI's research activities on beyond 3G mobile radio transmission technologies.As shown in figure 6, ETRI is developing four different mobile communications, the next generation wireless LAN, 3G Evolution, the High-speed Portable Internet (HPi/WiBro) system and the High-speed Mobile Multimedia (HMm) system in order to foster home grown beyond 3G mobile communication technologies. The next generation wireless LAN systems and the HMm system being developed as a low tier and a high tier B3G mobile systems respectively [8].

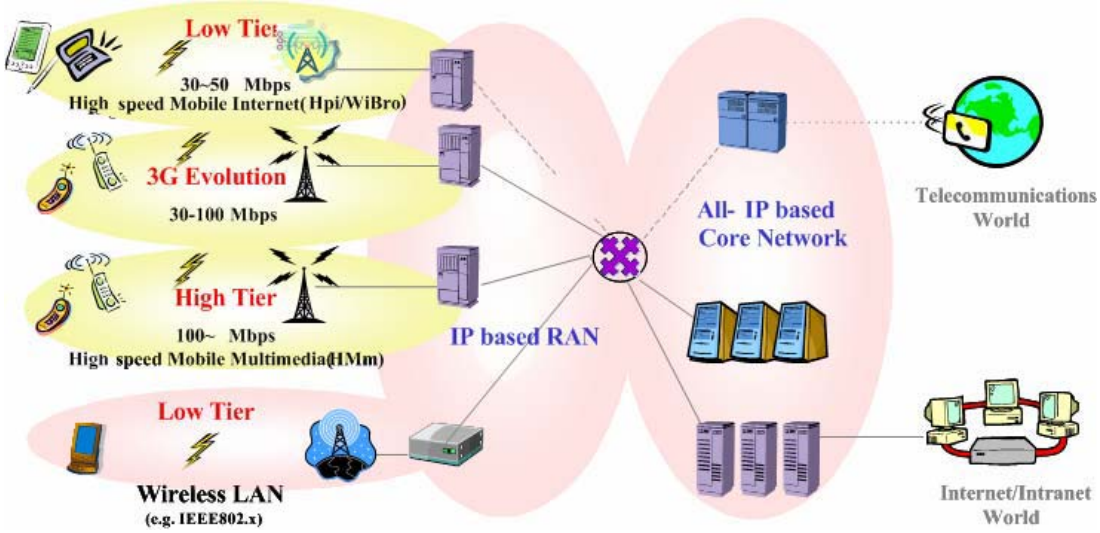

Fig. 6. Development of four different mobile communications technologies in ETRI

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