

主題

An Introduction to China High-Tech Research Project on Beyond 3G Mobile Communications FuTURE

Xiao-Hu You, Zhi-Wen Pan and Ahmed J. Jameel

차례

1. Introduction
2. Concepts and requirements of beyond 3G system
3. Contents and requirements of the project
4. Concluding Remarks

Abstract

This paper introduces the Future Technologies for Universal Radio Environment (FuTURE), which is China's wireless communications research project oriented to beyond 3G systems. The features and basic requirements of the FuTURE project are described, and the system structure, which is based on IPv6 core network, is proposed. The key techniques for FuTURE project are also addressed.

1. Introduction

Mobile communication is the most rapidly developing industry in China. From 1987 to 2000, the number of mobile users increases 100 % every year, and

now it is around 150 million. The total annual income is over 200 billion Yuan, which is one of the largest mobile markets over the world, and according to the prediction of Ministry of Information Industry, mobile subscribers in China will be more than 300 million by the year of 2005, with a penetration rate of over 20 %.

Now, 97% of the mobile users in China are using GSM system, and this may be changed soon. In early 2001, China Unicom launched IS-95A CDMA system deployment, and the network capacity will be over 40 million by the end of 2004 with 28 million subscribers while, China Mobile launched the GPRS system deployment.

Since second generation cellular systems can't accommodate the demands

of high-speed multimedia services yet, the preparation of commercialization of IMT2000 or third generation (3G) mobile communications has been in progress for recent years. China will finish the field test of 3G systems at the end of 2002, and will begin commercial deployment from 2003. Spring PCS, Bell Mobility, Verizon Wireless (North America), KDDI (Japan), KT (Korea) declared the beginning of commercial service of cdma2000-1x systems at the end of 2001. DoCoMo already started commercial service of WCDMA system in Oct 2001. Most of operators in Europe will carry on commercial trial of WCDMA system in 2002.

Due to prevalence of Internet services and rapid development of IP-based technology, the infrastructure of mobile communication systems tends to be all-IP based. 3GPP and 3GPP2 are now considering to establish all-IP based enhanced 3G standards. The cdma2000-1x/EV system with peak data rate up to 4-5 Mbps of 3GPP2 and HSPDA system with peak data rate up to 8 Mbps of 3GPP are proposed as candidates for enhanced 3G standards.

With the launching of commercial 3G systems, the researches on 4G systems have received much attention for recent years. Europe-Union has established a World Wireless Research Forum, and set to carry out researches on concepts, requirements, and overall frameworks of 4G/beyond IMT-2000. At the end of 2002,

Europe-Union will startup a research project "The sixth framework" to support researches on 4G systems. Japan and Korea also started research projects on 4G systems.

2. Concepts and requirements of beyond 3G system

In 1999, proposals of researches on concepts and requirements of beyond IMT-2000 systems were first scheduled in ITU. Then, in Oct 2001, at ITU-R WP8F meeting held in Tokyo, the overall framework of beyond IMT-2000 systems was preliminary recommended as follows:

Systems beyond IMT-2000 are those future wireless telecommunications systems that, collectively, will provide the elements of a comprehensive telecommunications environment which includes cellular, fixed wireless access, and nomadic access with capabilities that significantly exceed, but include, those anticipated for fully developed IMT-2000 systems and other radio systems with which they interwork and two new elements are added to it, i.e., cellular system supporting data rate up to 100 Mbps and nomadic/local area access networks supporting data rate up to several hundred mega bits per second.

Figure 1 illustrates the capabilities and system structure of beyond IMT-2000 systems, and researches on beyond 3G are the most significant issue.

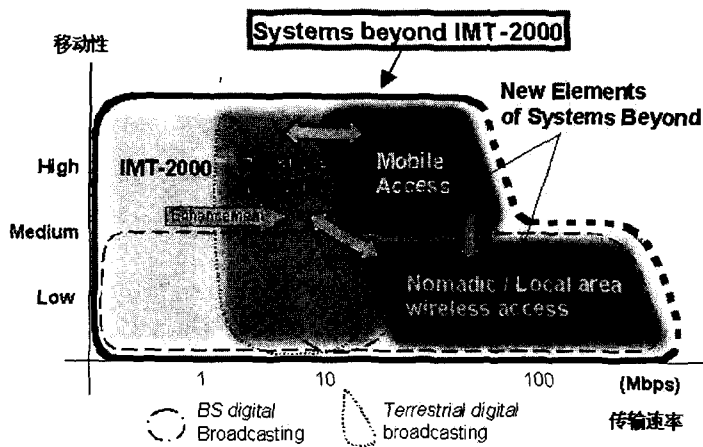


Figure 1. Illustration of capability and system structure of Beyond IMT-2000 system

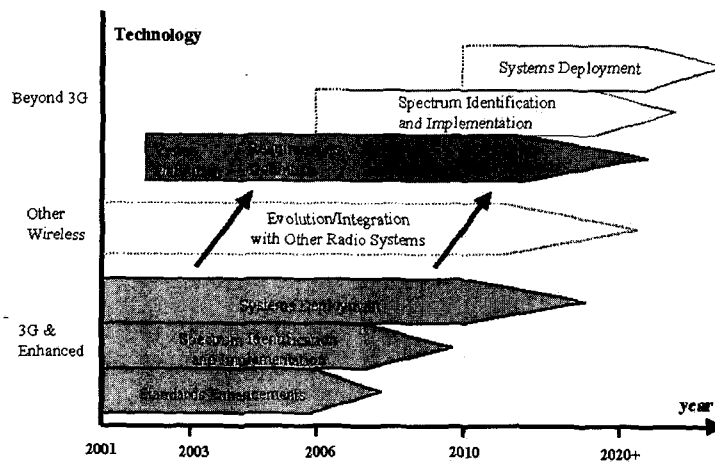


Figure 2. ITU's schedule for the researches on beyond IMT-2000

Figure 2 shows the ITU's schedule for researches on beyond IMT-2000. The overall object and vision will be completed in Jun 2002, spectrum plan will be carried on within 2005/2006, standardization procedure will be completed around 2010, and commercial deployment will begin after 2010.

From the above, it is clear that research-

ches on 4G mobile communications are just in budding phase. But the deployment of 4G systems will be around 2010. This is in accordance with the rule that a new generation of mobile communication system emerges every 10 years. In fact, researches on 3G systems began in the early 90s when GSM, PDC, and DAMPS came into commercial deployment. At that

time, research projects on FPLMTS were proposed, and after efforts of ten years, the standards of 3G are accomplished.

It is forecast by Chinese Authority that 3G markets will be over 1000 billion Yuan annually by 2010. Although the mobile communications market took the first place worldwide in 2001, the market share domestic manufacturers is still less than 20 in the last few years, mainly due to lack of core technologies. With the funding of the National 863 Program and Mobile Communications Fund of Ministry of Information Industry, the TD-SCDMA standard was proposed in 1998 and accepted by ITU in 2000 and subsequently 3GPP in 2001. Meanwhile, China's 3G (C3G) Project has been successfully performed and 3G field test systems, including TD-SCDMA, WCDMA, and cdma 2000-1x have been developed. These will greatly improve the competitiveness of domestic manufactures. In order to make China's wireless R&D coincide with the advanced countries in the future, Chinese government has decided to set-up a new project entitled "Future Technologies for Universal Radio Environment (FuTURE), in order to catch up with the international pace headed for the years of 2005-2010.

3. Contents and requirements of the project

According to the plan, the research project on radio transmission technology

for next generation cellular mobile communication is an important part of the FuTURE (Future Technology for Universal Radio Environment) project, the wireless communication branch of communication subject of national 863 program. It aims to carry out investigations on key technologies for air interface of beyond 3G/4G mobile communication system, to set up demonstration systems to verify the key technologies that can support future wireless services, to improve the Chinese overall research capabilities in mobile communications and to enhance China in international competition during the standardization process of future beyond 3G/4G wireless communication systems.

As a kernel part of the FuTURE project, the overall project on beyond 3G/4G consists of three phases:

- **Phase 1 (Dec 2001-Dec 2003).** In this phase, investigations on key technologies for air interface of beyond 3G/4G system and development of demo systems for verification of the key technologies will be finished, demonstration of various future wireless services on the demo system will be carried on, and some corresponding proposals will be submitted to ITU.
- **Phase 2 (Jan 2004-Dec 2005).** In this phase, researches on air interface of beyond 3G/4G system will continue to make it mature, and

researches on systematic technologies (including technologies on the inter-connectivity with ad hoc networks and nomadic wireless access network, etc.) will be carried on. Field test of the demo system with the ability to bear beyond 3G/4G services inter-connected with other external networks will be carried out. Preliminary standardization documentation for beyond 3G systems will be submitted to ITU.

- **Phase 3 (Jan 2006-Dec 2010).** In this phase, major special projects will be launched to support large-scale field trial and completion of standardization documentation for the beyond 3G/4G system for universal radio environment.

Technically, 4G systems should have essential differences compared to IMT-2000 and enhanced 3G systems. This is due to the requirement that peak data rate of 4G mobile communication system should be 20-100 Mbps, which is 10-50 times that of 3G systems. If only nowadays technologies as in 3G systems are employed in future 4G systems, the transmit power should be 10-50 times that of 3G systems, leading to unacceptable electromagnetic interference. New space-time signal processing technologies, joint transmission/detection and turbo receiver in multiple antenna environments should be adopted to greatly lower the transmit power.

On the other side, DS-CDMA technologies, which are widely used in 3G systems can't be used directly in 4G systems due to the difficulties in dealing with large bandwidth. Air interface based on OFDM and multiple carrier (MC) technologies combined with CDMA or TDMA will be powerful candidates. The core network of 4G systems should be IPv6 based since IPv4 can't provide sufficient addresses.

Based on the considerations discussed above, the main technical features of the beyond 3G cellular systems in our project include:

- IPv6 based core networks.
- Separated bear and control.
- Support seamless roaming and handover of MIP/M-eN.
- Wireless access network should be transparent to core network. Call control/mobility management functions reside in core network side, and RR/LL/PL resides in access stratum.
- Support classified end-to-end QoS for real time services should be better than telecommunication grade.
- Employment of space-time joint processing, and network diversity such that the transmit power can be 10 dB less than that of 3G systems.
- Burst data oriented air interface that can support peak data rate within the range 20-100 Mbps with the capability to allocate radio resource flexibly.

- Seamless inter-connect with territorial wireless access system and self-organizing or *ad hoc* network.

Due to the time limitation, it is impractical to develop demo systems with full 4G technical features in phase 1 (two years). Thus, the object of phase 1 of this project consists of two parts, the demo systems for verifying key technologies, and computer simulation platform with the following requirements.

(1) Beyond 3G demo system

Air interface should be beyond 3G oriented (based on OFDM, MC or other technologies), can support radio resource sharing among several terminals, and support packet transmission of 8 kbps-20 Mbps data rates and of different QoS. The system consists of an access point (AP) and two mobile terminals (MT). AP can inter-connect with high-speed packet networks and can communicate with at least two MTs with peak rate not less than 20 Mbps at BER less than .

(2) Investigations on key technologies for beyond 3G wireless transmission

It consists of simulation platforms of key technologies for beyond 3G wireless transmission and technical reports, patent application documents. For the simulation platform, it is required to support radio resource sharing among

several MTs with data rate from 8 kbps to 20 Mbps and with different QoS, and system capacity should be 3-5 times that of 3G systems. Technical reports and patent application documents on beyond 3G wireless transmission key technologies should cover such as time and frequency synchronization, anti-multipath and Doppler shift, pilot design, joint transmission/detection, and radio resource management technologies, etc., and their technical specifications.

4. Concluding Remarks

- ◆ The FuTURE project was launched in last year as a part of the Chinese 863 Program in Wireless Communications Area for the 10th five-years plan (2001-2005).

- ◆ The Mission of FuTURE is to establish a universal radio experiment environment that can meet the future application demands and development trends headed for years of 2005-2010, and to make China's wireless R&D coincide with the advanced countries.

- ◆ **International collaborations are highly encouraged for the FuTURE project.** An international coordination group will be set-up to steer up the FuTURE project.