Future Information-communication Technology in China

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OVERVIEW: Together with having the most populous, fastest-growing major economy in world history, China will come to dominate the new "ubiquitous technology" market that is growing with the coming of the "ubiquitous-information-network society." In such a situation, Hitachi (China) Research & Development Corporation (HCR&D) has started research related to information-communication technologies such as mobile, broadband network, network management, and optical access—whose markets are led by China. HCR&D has also launched several collaborations with Chinese universities, research institutes, and telecom R&D centers to support those directions to exploit this research.

INTRODUCTION

BY the end of 2005, the number of telephone subscribers in China had risen to about 700 million. Among them are 400 billion mobile-phone users and 300 billion fixed phones. Meanwhile, second only to the USA, China boasts the No. 2 position in the world in terms of both Internet users and broadband Internet subscribers. At its current growth rate of over 90% per year, China will surpass the USA in total broadband subscribers by late 2006 to become the largest broadband country in the world.

Accompanying this rapid growth in the broadband market, competition in China's telecommunication market is becoming more severe. Almost all major vendors around the world have come to China. They have set up sales teams, localization development, and technical support teams, etc. Over time, more and more companies feel that they must have a core-technology R&D lab in China in order to succeed in this challenging market and grab a share of the opportunities in this growing country.

In the future Chinese telecommunication market, anybody, anywhere at anytime—known as "wherever, whenever, whoever" access—should be able to access future telecommunications services, such as 3G (3rd generation) and Internet access, in a cheap, safe, and efficient way in order to appreciate a more joyful, colorful, and fashionable life. Aiming toward that goal, and by jointly considering technology like QoS (quality of service), network management, multicast, security, and mobility, Hitachi believes that fixed [IP (Internet Protocol) and circuit] and mobile (3G and IEEE) convergence is becoming more and more promising in China (see Fig. 1). People at home or working in enterprises use various kinds of terminals

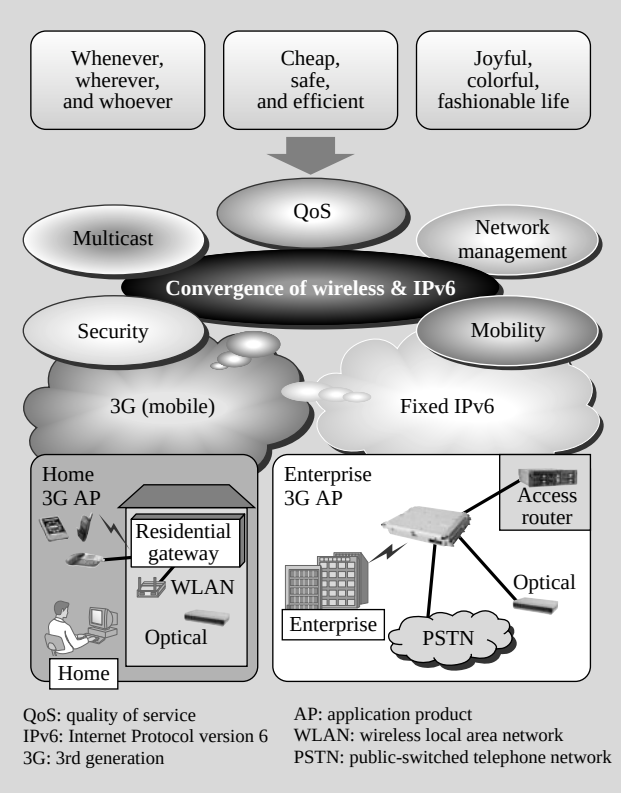

Fig. 1—Converged Future Communication Network Scenario in China.
It shows the future network scenario in China, where the infrastructure includes mobile networks (such as 3G) and fixed networks (like IPv6) accessed by optical, PSTN, and broadband connections.

[3G and WLAN (wireless local area network)] and access technologies [optical, xDSL (generic digital subscriber line), 3G, WLAN, etc.] to browse the Internet, join a video teleconference, or watch TV.

Furthermore, given that China already has the largest subscribers in the 2G (2nd generation) mobile-technology market, it may come to dominate future 3G, B3G (beyond 3G), and IPv6 (Internet Protocol version 6)-related information-telecommunication markets as well. Seeking to take this opportunity in China, Hitachi has organized an R&D team [HCR&D: Hitachi (China) Research & Development Corporation] for working on those information-communication technologies. And since China also has a huge pool of talented young researchers in its universities and institutes, HCR&D started several collaborations with several top Chinese universities and established many joint laboratories.

In the following sections, we will first focus on two fields to realize the above-mentioned future telecommunication trends: next-generation information technology about 3G, next-generation Internet technology in China. After that, the joint labs set up by Hitachi with Chinese universities and future information technology in China are described in detail.

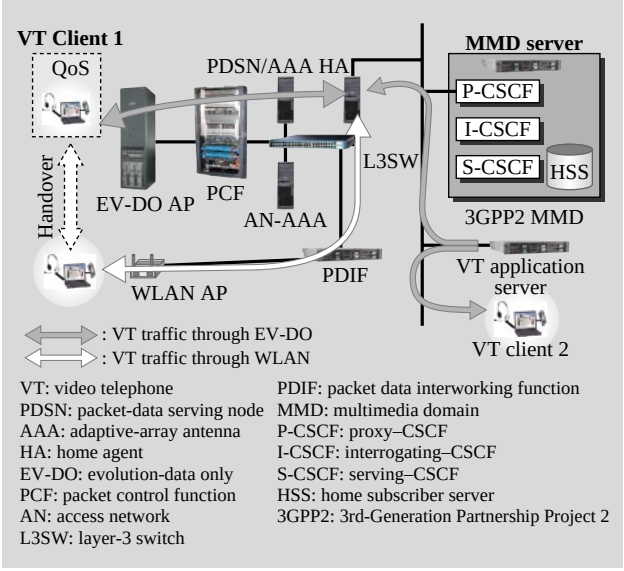

Fig. 2—Outline of Video-telephone Handover between EV-DO and WLAN.
It shows the handover between MMD-based video-telephone services, i.e. 3G CDMA (code division multiple access) 1x EVDO and wireless LAN. Seamless handover from 3G to wireless LAN is achieved.

NEXT-GENERATION INFORMATION-COMMUNICATION TECHNOLOGY

Aiming toward a ubiquitous network society, our research focuses on wireless (IEEE802.16/11), mobile (3G, B3G), and broadband network technology (IPv6 router and optical). In the following, 3G-related technology is mainly described.

Video-telephone Handover between EV-DO and WLAN

Recently, integration of fixed and mobile communications has become popular; especially, this will happen in China after 3G licenses are issued. This technology provides access to CDMA (code division multiple access) 2000 1xEV-DO (evolution-data only) mobile services over unlicensed spectrum technologies such as IEEE 802.11. By deploying this technology, service providers will enable subscribers to roam and handover between cellular networks and public and private unlicensed wireless networks by using dual-mode mobile handsets.

With this technology, subscribers can receive mobile voice and data services as they transfer between networks. They can expect to use their video telephone as a mobile and get high-speed Internet access seamlessly at home or on the street through various kinds of wireless access technologies. The basic requirement is that no data be lost and voice interruption will not occur during handover. We made a special virtual delivery to support a virtual network interface and schedule packet delivery between two different interfaces, thereby achieving seamless handover. HCR&D staged the world's first demonstration of videotelephone handover between 3G EV-DO and WLAN in October 2005 at PTCOMM China (see Fig. 2), thus proving that seamless handover between 3G and WLAN is possible.

PoC over EV-DO BCMCS System

CDMA 2000 1x EV-DO has the ability to support multicast and broadcast systems, and PoC (push to talk over cellular) already has many applications in China. How to integrate PoC and realtime BCMCS (broadcast and multicast system) in a 3G EV-DO system is the start point. Voice delay in the PoC system would be less than 500 ms, so we revised the buffer schedule algorithm in the base station and aggregate routers in order to make packet transfer faster than traditional broadcast and multicast systems. In this way, HCR&D made the world's first demonstration of PoC over a realtime BCMCS system

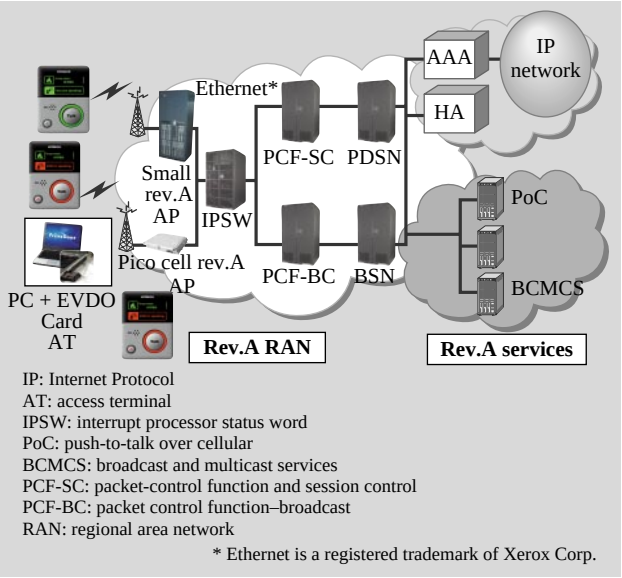

Fig. 3—Outline of Realtime PoC over 3G EV-DO Network.
It shows the BCMCS-based "PoC" service on a 3G network based on broadcast and multicast technology. With this configuration, the amount of signal and data traffic in the air interface is reduced.

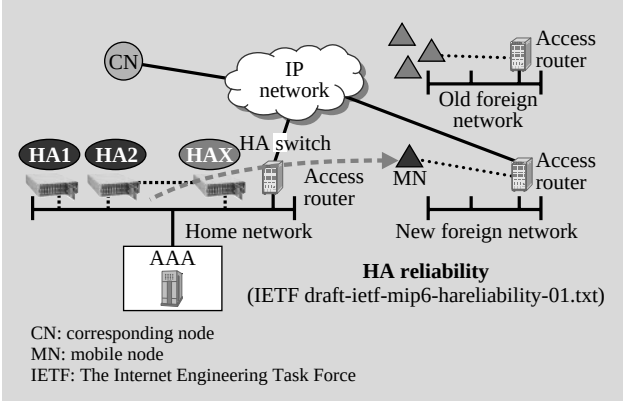

Fig. 4—IETF's Solution for HA Reliability.
It shows the contribution of HCR&D to two IETF working-group drafts: one on HA reliability and the other is on HA switches. In this solution, multiple HAs can notify a mobile node to dynamically switch to another HA.

(see Fig. 3), in which delay was less than 500 ms. With this technology, a multicast PoC voice stream can be delivered over a 3G EV-DO network and can significantly reduce the amount of additional air-interface signals and data traffic.

NEXT-GENERATION INTERNET TECHNOLOGY IN CHINA

The CNGI (China Next-Generation Internet Project) was started in early 2003 and funded with US$ 170 million in appropriations for constructing a big IPv6 network by the end of 2006. This will cover the whole country, including more than 20 cities, 39 core nodes, and 300 access nodes. As a result, China will become the country with the largest IPv6 network infrastructure. The CNGI is led by National Development and Reform Commission (NDRC), jointly with the Ministry of Science and Technology, the Ministry of Education, the Ministry of Information Industry, the Chinese Academy of Engineering (CAE), etc.

As part of CNGI, the telecom operators, including China Telecommunications Corporation (China Telecom), China Unicom Limited, China Network Communications Corporation, China Mobile Communications Corporation (China Mobile), and China Railway Communication Co., Ltd., along with the academic network "CERNET (China Education and Research Network Center)" and "CSTNET (China Science & Technology Network)," are responsible for constructing their own IPv6 core networks and connecting them together through a special network transit center.

As one of the leading companies involved in IPv6 technology, Hitachi is also actively involved in this large Chinese national R&D project, in which one topic is mobile IPv6 HA (home agent) reliability. An HA is a single point of failure in a mobile IPv6 network. It is thus critical to improve reliability of HAs in the event that one crashes. HA reliability allows another HA to continue providing a service to a given mobile node. Security associations and binding caches should be synchronized between multiple HAs. By proposing IPsec (Internet Protocol–security) context transfer, our solution has been included in IETF (Internet Engineering Task Force) standardization (specification draft: ietf-draft-mip6-hareliability-01.txt)

Since HCR&D is actively involved in international standardization activity, HCR&D cooperated with the CNGI Expert Committee, which has been hosting a future IP-related workshop each year since 2004. As the chair of the organizing committee, HCR&D invited many working-group chairs from IETF, IEEE (The Institute of Electrical and Electronics Engineeers, Inc.), 3GPP2 (The Third Generation Partnership Project 2), and 3GPP. Meanwhile, the CNGI Expert Committee also invited a CTO (chief technology officer) of China Mobile and China Telecom, senior technical managers from China Unicom and China Netcom, and a director of CERNET to make a speech in this workshop. We believe future IP technology will be a convergence of

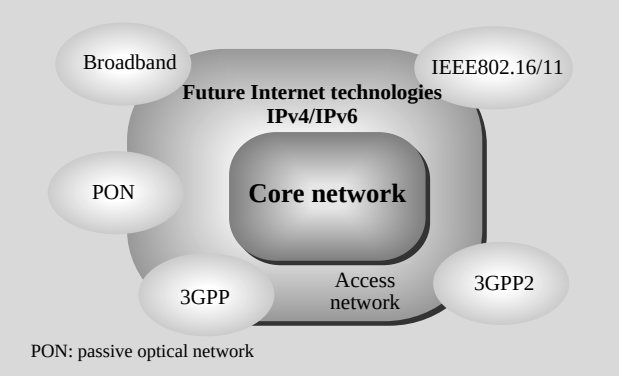

Fig. 5—Converged IP Technology over Various Kinds of Access Technologies.
It shows the future trend in communication networks, including various kinds of access technologies, such as 3GPP, 3GPP2, IEEE WiMAX, Broadband, and PON.

TABLE 1. Hitachi's Joint Labs with Chinese Universities
This table lists Hitachi's research topics and associated academic partners in China, namely, wireless technology with Tsinghua University, e-business with Fudan University, digital home appliances with Shanghai Jiaotong University, and PONs with Beijing University of Post and Telecommunication.

Name of University	Started in	Research direction
Tsinghua University	2001	Next-generation wireless technology
Fudan University	2004	e-business and WAP service
Shanghai Jiaotong University	2004	Digital home appliances
Beijing University of Post and Telecommunication	2006	Next-generation PON

WAP: wireless application protocol

various kinds of access technologies such as IEEE, 3GPP, 3GPP2, and PON (passive optical network) (see Fig. 5).

HCR&D and the CNGI Expert Committee jointly sponsored several talented students from Chinese universities to attend and present at IETF meetings.

JOINT LABS OF HITACHI AND CHINESE UNIVERSITIES

China has a huge pool of talented young researchers in universities and institutes, and lots of advanced technologies have thus been developed locally in China. In consideration of such a situation and Hitachi's business direction, from 2001 to 2006, Hitachi launched four joint laboratories with local Chinese universities in order to promote Hitachi's competitive cutting-edge technology in the Chinese market.

Tsinghua-Hitachi Joint Lab and Forum

Tsinghua University, from which both the current President and Prime Minister of China graduated, was established in 1911. Hence, to study at Tsinghua is the dream of many Chinese youths. HCR&D and Tsinghua University set up Tsinghua-Hitachi Ubiquitous IT Joint Laboratory in 2001 to conduct research on next-generation wireless-communication

Fig. 6—Workshop for New Trends of Next-generation Internet. Mr. Leping Wei, CTO of China Telecom is explaining to the audience about China Telecom's next-generation Internet technology.

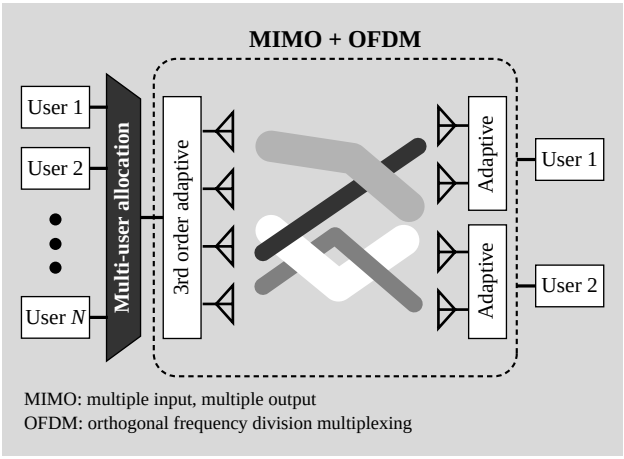

Fig. 7—Example of Next-generation MIMO-OFDM Wireless Communication Technology.
It shows trends in wireless-communication technology based on MIMO and OFDM. A wireless user can use multiple antennas and OFDM to enhance the performance of their terminal.

technology. By developing MIMO (multiple input, multiple output) and OFDM (orthogonal frequency division multiplexing) wireless technology, full, effective and efficient use of multi-dimensional radio resources (frequency, time, code, and space) becomes possible and efficiently under the diverse QoS requirements (see Fig. 7). This technology will be one of the key technologies in 3G and B3G which could strengthen competitive Hitachi's technology and will strengthen Hitachi's competitive edge.

Fudan-Hitachi Joint Lab

In 2004, a contract of cooperation was signed with Fudan University to perform joint research in e-business and WAP (wireless application protocol) service fields, and Fudan-Hitachi Innovative Software Technology Joint Laboratory was established to work on advanced software technology. This joint lab mostly focuses on high-level-system operation management and SOA (service-oriented architecture). Through this research cooperation, we are expecting to expand Hitachi's business in China.

FUTURE INFORMATION-COMMUNICATION TECHNOLOGY IN CHINA

In the field of next-generation information-communication technology, Chinese workgroups have developed several competitive technologies, such as TD-SCDMA (time division–synchronous code-division multiple access) and AVS (audio-video coding standard). China is also deploying the world's largest next-generation IPv6 Internet, and optical access to the home has already started up from China's fixed operators such as China Telecom and China Unicom. Moreover, television services will come to ordinary Chinese people through IP and mobile phones. HCR&D will closely cooperate with local Chinese universities and telecom operators in order to contribute to this fascinating new world, and in doing so, these technologies will also be transferred to the whole world.

CONCLUSIONS

HCR&D has a lot of talented researchers in the current research fields and enjoys very close cooperation with several famous Chinese universities, such as Tsinghua Univeristy, Fudan University, and Shanghai Jiao Tong University. Our dream is to become a world-leading research center for making a safer and more comfortable society through information-communication technologies while nurturing many superior researchers who cam make that dream into reality. We aim at keeping pace with China's global ascendance, dominating world-class technology in China, and becoming a key global R&D institute of Hitachi based in an innovative China.

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