Next-Generation Converged Networking in Korea: The Concept and Its R&D Activities

Kug Chang Kang, No Ik Park, Soon Seok Lee, Young Sun Kim, and Kyung Pyo Jun

Abstract: **In Korea, we witness vivid evidences of changing trend in communication that insist the emergence of new networking architecture. To accommodate the changing trend and to hold current strong position in global IT industry, Korea have launched broadband convergence network (BcN) initiative. BcN vision for Korea is to be the first in the world to realize converged network infrastructure and ubiquitous service environment.**

In this paper, we have introduced the concept and the vision of BcN with a viewpoint of a new paradigm to prepare future-proof communication environment. And then, we have disclosed BcN research and development (R&D) activities including R&D philosophy, R&D phases, and key technologies required. Also, we have discussed current development issues in three technology branches including service and control technology, unified transport technology, and next-generation access technology.

Index Terms: **Broadband convergence network (BcN), networking architecture, next-generation network (NGN).**

I. INTRODUCTION

Korea is one of the most advanced IT countries. There are 12 million Internet users and 38 million mobile phone users already. Monthly communication expenditure per household is around $130, which is two times higher than average expenditure of three countries—US, UK, and Germany—which is $65 per household. The ratio of communication expenditure to the total household expenditure is about 6.5%, which is three times higher than the average ratio of OECD countries. These figures imply that communication demand in Korea is being saturated.

With the saturating demand, user needs is changing also. Demand for high-quality multimedia services is rapidly increasing, needs for mobile communication is growing faster. Interactive and peer-to-peer traffic prevail client-to-server traffic. More and more, people self-generate their own content to distribute it all over the country from personal Internet blog or personal Internet broadcasting station.

To accommodate these changing needs and at the same time to hold current strong position in global IT industry, Korea is enthusiastically building the grounds for next generation information society. At the heart of Korean IT activities is the building of future-proof network infrastructure called broadband convergence network (BcN).

In this paper, we are going to introduce the concept and the vision of BcN. Also, we will disclose the details of research and development (R&D) activities with its direction, development phases, target, and current R&D issues.

Manuscript received April 30, 2006;.

The authors are with the Electronics and Telecommunications Research Institude (ETRI), Korea, email: {kckang, nipark, sslee, sunkim, kpjun}@etri.re.kr.

II. BCN CONCEPT AND VISION

Through BcN, Korea has a vision to be the first in the world to realize converged network infrastructure and ubiquitous service environment. BcN's goal is to complete network convergence by 2012, and to provide quality of service (QoS) guaranteed services at the speed of 100 Mbps to 29 million fixed and wireless subscribers [1]. To encourage successful deployment of BcN, high-tech R&D network was established to develop and verify BcN equipments and technologies such as QoS router, access equipment, streaming technology, multicasting technology, etc. Also, BcN pilot projects are being carried out to develop BcN services and to expedite the commercialization of BcN product. Through the pilot project, various BcN service models are developed such as multimedia over IP (MMoIP), video on demand (VoD), digital CATV (DCATV), triple play service (TPS), T-government, T-commerce, etc.

In the term of BcN, broadband stands for broader bandwidth and multiple spectrums of data band. Here, convergence means that all kinds of services are integrated on a single media—voice and data services, fixed and mobile services, and telecommunication and broadcasting services. And here, network means a unified integrated platform that is highly reliable and QoS-enabled. Hence, BcN can be described as; a next-generation unified network that provides converged and QoS guaranteed broadband multimedia services in seamless and secure way at anytime, anywhere.

In a narrow sense, BcN can be regarded as a Korean effort corresponding to global effort to prepare next-generation network (NGN). It is true when it comes to technological aspect only. Actually, BcN conforms to the principles of ITU-T NGN architecture and characterized by de-coupling between service provisioning and transport network, separation of control functions from bearer capabilities, and so on [2].

BcN in a broad sense is, however, not just only technological effort. To make BcN as a future-proof communication infrastructure, we are considering various aspects such as new value chain of communication industry, new business models, new life-style, etc. In other words, BcN vision for Korea is to make a new paradigm to prepare future-proof communication environment.

III. BCN R&D ACTIVITIES

A. R&D Philosophy

To take steps in the right direction for BcN R&D, we have analyzed problems of legacy networking architecture with regard to authentication, authorization, and accounting (AAA), QoS, service level agreement (SLA), routing, and so on. From the analysis, we have devised new features of BcN to overcome the

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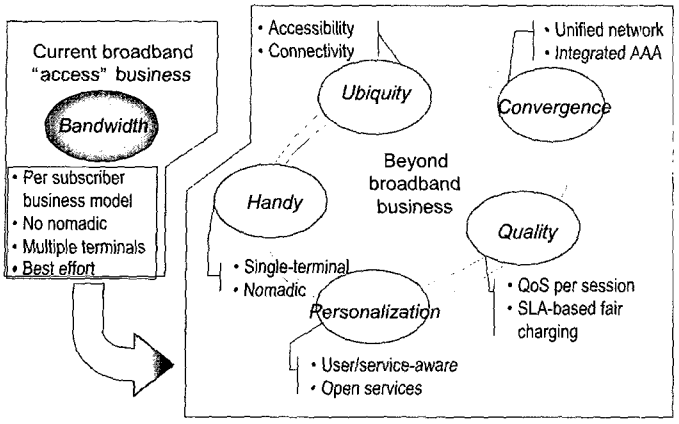

Fig. 1. Requirement of new business model.

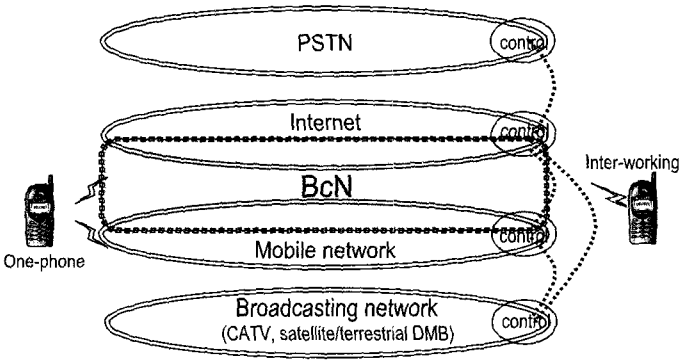

Fig. 2. BcN Phase 1.

current problems.

Incorporating above mentioned considerations, we are making a comprehensive approach considering many-sided requirement for future networking. From demand side, consumers ask for personalized and valuable services with more quality, more speed, more interactivity, and so on. From industry side, network providers want to have a network that can make more revenue with less expenditure. Other market players like equipment vendors or content providers seek for rich market opportunities that are enough to motivate their product development. From government side, new growth engine is required to continue economic development.

The most essential aspect of R&D direction we are taking into account is about new market opportunity. For the BcN to be successful, it should offer profitable business models to network or service providers since the providers are main financial supporters of BcN construction. The more profit they could make, the more money they will invest.

At present, business models of the telecommunication industry are based on broadband access. Carriers' profit formula is only a function of subscriber number. No matter how much traffic is generated and no matter what kind of service is used, subscribers pay only a fixed monthly charge. Under the situation, it is difficult to increase average revenue per unit (ARPU) so total revenue becomes stagnant once the number of subscriber is saturated.

To create abundant business model, more variables have to be added into the profit formula such as quality, personalization, mobility, and so on. Fig. 1 shows five factors to create new business model [3].

QoS based user-aware service is one of the main gears requirement of new business model that can change current profit structure. Users will pay as they use what service, how much and at what quality. On the other hand, ubiquitous access and seamless service mobility are indispensable features to make a service more valuable. Convergence of service and network will cut down capital expenditure (CAPEX) and operational expenditure (OPEX). From the perspective of network, we can derive three key success factors to support the new communication business in the coming converged and ubiquitous era; QoS guaranteed all Internet protocol (IP) network, user/service-aware converged access, and seamless mobility control.

B. R&D Phases

To achieve BcN in the right order and at proper time, we have set BcN evolution path into three phases according to the convergence level of services and networks [4].

At Phase 1, each network still exists independently and has its own control function. The management for billing, subscribers, and services remains independent. Only a part of the Internet and mobile network are covered by BcN. Services are provided in a combined type or by inter-working between different networks.

Combined services are supported by physical combining of two different functions on a user terminal. For example, 'one-phone' has both public switched telephone network (PSTN) module and code division multiple access (CDMA) module so that it can be used as a PSTN phone within home area, and switched to a CDMA phone at the outside. In this way, wireless fidelity (WiFi) and CDMA, wireless broadband Internet (WiBro) and CDMA, and digital multimedia broadcasting (DMB) and CDMA can be combined for service providing.

Inter-working services are supported by the inter-operation of control functions of two networks. PSTN-Internet phone and PSTN-CDMA phone are examples of inter-working service. Key technologies at this phase are; broadband access technology, E-PON/WDM-PON technology, WiBro access technology, open API technology, and so on.

At BcN Phase 2, fixed and mobile convergence is on the move. The second phase consists of the Internet and a large part of mobile network. Heterogeneous services are integrated through the gateway function between networks, so users could enjoy different services and pay for it on a single interface.

There is an integrated business management system (BMS) to manage billing, subscribers, and services in a single centralized point. Network access and service control are integrated also. While the inter-working services are provided by inter-operation of two separated controls, integrated services are under a single control. In this phase, service mobility is supported by the type of roaming service.

Key technologies required in the second phase are; integrated service management and control technology, integrated fixed and mobile access technology, managed IP transport technology, and so on.

The third phase of BcN is for the completion of the BcN evolution. BcN covers all kinds of networks in a unified plat-

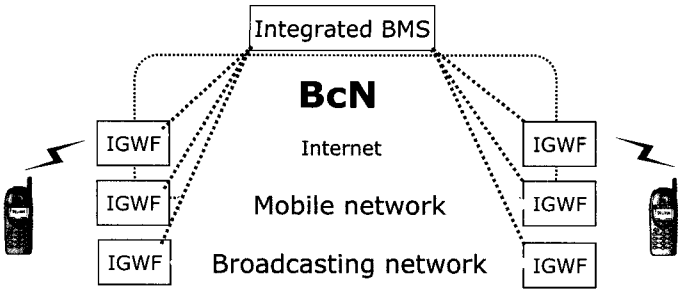

Fig. 3. BcN Phase 2.

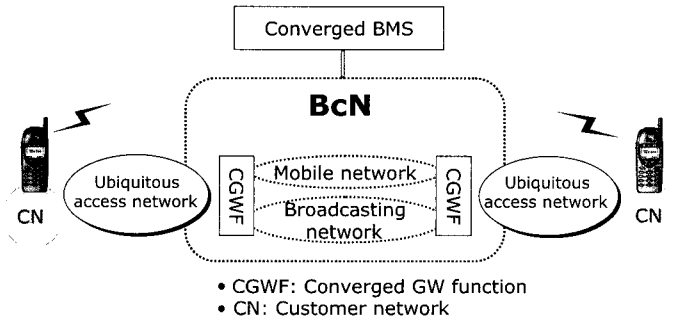

Fig. 4. BcN Phase 3.

form with unified subscriber management, unified service control, unified transport network, and fully converged access. On the other hand, ubiquitous access and ubiquitous networking are expected to be accomplished to a high degree. So, we call the BcN Phase 3 as ubiquitous BcN (u-BcN).

We expect that the u-BcN would open the era of mobile multimedia services by realizing seamless and fast mobility while in BcN second phase, roaming service provides service mobility.

C. Key Challenges of R&D

To make smooth BcN evolution and to attain the final phase of BcN, lots of technologies are to be developed. Considering the requirement of future converged and ubiquitous networking, we have derived key R&D targets in four areas; open service area, service and control area, access technology area, and transport technology area [4].

In Fig. 5, the list of the technologies is shown, which we are challenging to secure from BcN R&D activities. Among them, we are currently focusing on 3 technology branches as a fundamental challenge of BcN R&D. They are service and control technology, transport network technology, and next-generation access technology.

- BcN service and control technology

The first key challenge is to provide BcN with new service and control stratum.

At present, service creation is dependent on network characteristic. Application service area is so limited that it is difficult for service providers to make profit. On the other hand, it is hard to support seamless service convergence. Networks are partially integrated based on soft-switch or IP multimedia subsys-

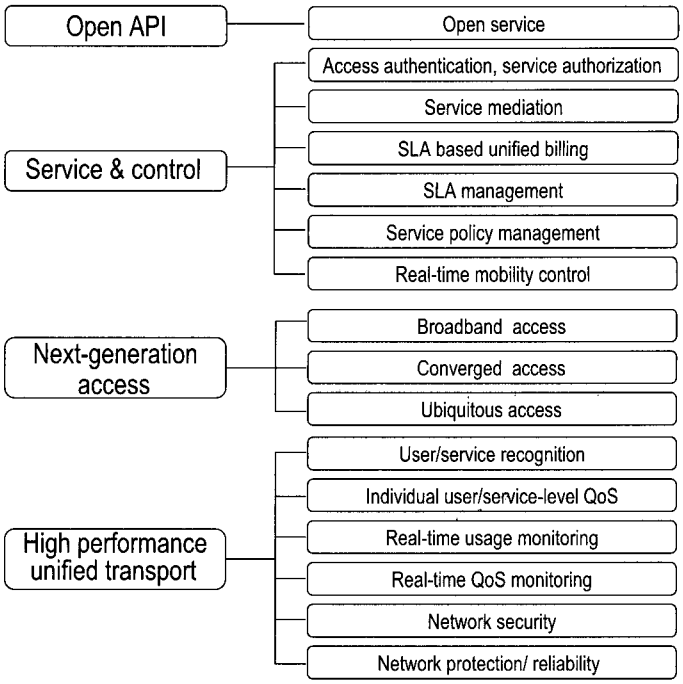

Fig. 5. Technologies required for BcN.

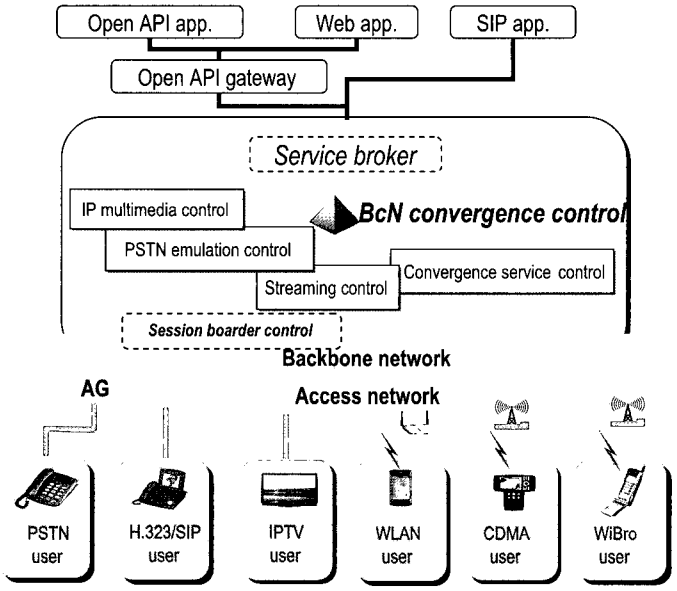

Fig. 6. Structure of service and control platform.

tem (IMS). Each network is doing service and network control individually.

We are challenging to prepare open service environment and to attain seamless service convergence. Through the expansion of open API, we expect that a great many competitive service providers could create various and valuable BcN services. For the seamless service convergence, the most crucial thing is a unified service and control platform that supports mobility and service continuity.

Fig. 6 shows the structure of an open and seamless converged service environment [4]. Main R&D effort concentrates on a standardized and unified convergence control technologies such

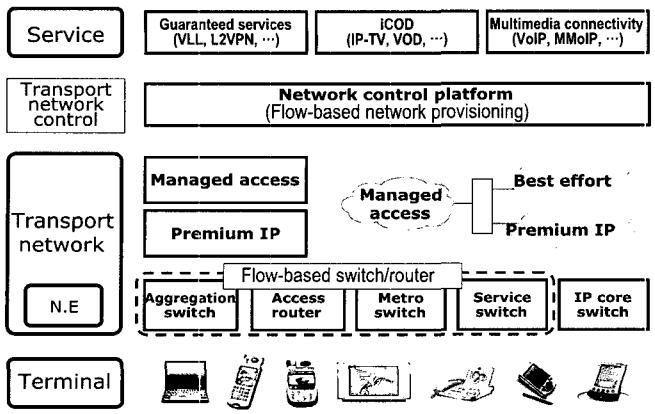

Fig. 7. Structure of new IP transport.

as IP multimedia control, streaming control, convergence control, etc.

- BcN transport network technology

The second challenge is to create a new IP transport by the building of novel network control stratum.

Current IP transport supports class of service (CoS) service only and subscriber-line based AAA policy. For emerging communication needs, however, transport network should support differentiated and personalized premium services with end-to-end QoS. To make an enhanced transport network, lots of functional feature are required; provisioning of differentiated value services through flow level traffic control, end-to-end QoS guarantee through enhanced subscribers and service management incorporating legacy access networks, and so on. Flow-based control capability is an essential feature of BcN to guarantee service QoS and to enable value communication [5], [6]. As well, fast handover between different IP networks through L3 mobility is another essential function of future transport capabilities.

A structure for the new IP transport is as shown in Fig. 7 [7]. Consisting of managed access and QoS-capable switch/router, the new IP transport is a managed IP transport supporting flow-based network provisioning.

Network control platform (NCP) and QoS switch router (QSR) series are key R&D products for the new IP transport. NCP is a centralized network control platform that performs various functions such as resource provisioning and management, per-flow and per-service call admission control (CAC), policy-based access control, monitoring and statistics gathering, billing mediation, and so on.

QSR Series are QoS-capable flow-state routers that have a capacity to handle 6 million flows per second. The series consists of QSR80 as access edge service node (A-ESN), QSS120 as metro transport node, and QSR240 as edge service node (ESN) including developed and developing.

Actually, a total of 24 systems of QSS120 had been installed by the end of last year, including 5 systems on BcN pilot networks, 3 systems on BcN R&D network, 15 systems on e-government network. Fig. 8 shows a typical topology of managed IP transport network with NCP and QSR series.

- BcN access technology

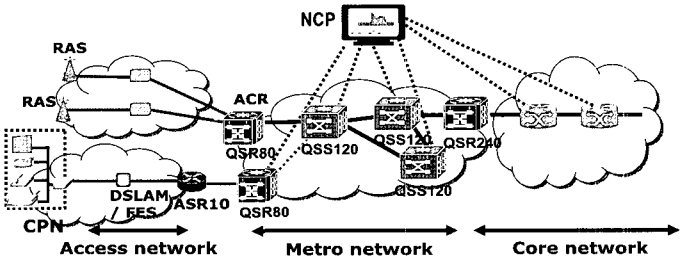

Fig. 8. Managed IP transport network.

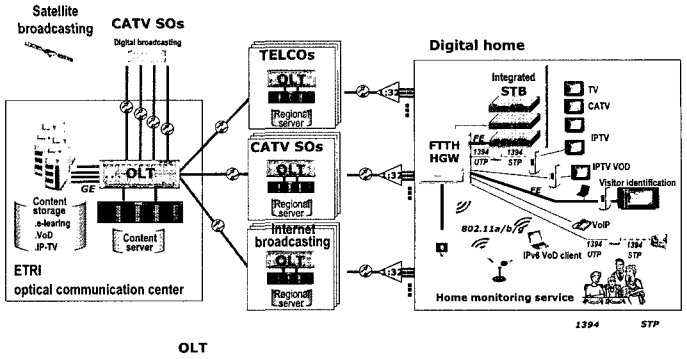

Fig. 9. FTTH service experiment.

The third challenge is for next generation access technologies to accommodate future mobile multimedia services and high-data rate services like IPTV. The main focus of R&D is on PON based FTTH and low cost optical link technologies.

Through the new access technologies, we are developing economic solution that costs only 10% of xDSL cost for the same amount of bandwidth and that cuts down 40% of OPEX in subscriber network. The goal is to commercialize low-cost access technologies supporting QoS guaranteed convergence services.

As for FTTH, technology competitiveness will be obtained by low-cost and high-speed WDM-PON type. Core technologies are planar lightwave circuit-external cavity laser (PLC-ECL) and reflective semiconductor optical amplifier (RSOA) of our unique design and packaging method.

We have deployed optical infrastructure using our own-developed FTTH technologies—E-PON, WDM-PON, and G-PON. Through a FTTH experiment project, we have tested 100 Mbps Internet service and TPS such as IP-TV, digital cableTV, VoD, education on demand (EoD), game on demand (GoD), and so on. The goal of this project is to commercialize the developed FTTH technologies and to bring up FTTH-based content industry. Fig. 9 shows a test network of the experiment [8].

IV. CONCLUSION

BcN can be defined as a new approach for future communication paradigm. BcN initiative is not just about technological evolution, but also about business evolution and about cultural revolution. Firstly, BcN is an essential infrastructure for attaining future ubiquitous society where we can enjoy any connectivity anytime anywhere. Secondly, BcN is a driving force that creates rich market of value communication based on personalized services and mobile multimedia services. Third, BcN opens

the door of business opportunity for all sorts of communication players including telcos, carriers, mobile operators, service operators, content providers, equipment vendors, and so on. All kinds of communication businesses are converged onto the BcN territory.

The vision of BcN R&D is to take architectural and technological initiative in the era of ubiquitous networking and seamless mobile multimedia. Under this vision, we place strong emphasis on three technology branches as a key R&D challenges for the evolution of BcN.

For service control and management branch, unified AAA and seamless session mobility control will be realized. This can be done through the building of unified service and control platform.

For transport network branch, flow-based traffic control and fast handover between different networks will be supported. NCP and QSR Series are the core transport technologies for the new transport capability.

For access network branch, there are two goals to achieve. One is low-cost but high-performance access, and the other is seamless and converged access. One of the most economic access solutions is PON-based FTTH.

It is true that the BcN effort in Korea has its domestic goal to provide key driving forces of the Korean economy. Though, BcN vision is to prepare next-generation converged and ubiquitous networking. BcN initiative could, consequently, prompt a global initiative to make timely and proper plans for attaining future ubiquitous society. To realize BcN vision as a global initiative, comprehensive approach with global collaboration is required; not from a technological viewpoint but from human and cultural viewpoint, and not from a national viewpoint but from a global viewpoint.

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Kug Chang Kang is a senior member of BcN Architecture Team in ETRI, Korea. He received a Ph.D. degree and an M.S. degree from the Seoul National University, Korea in 1997 and 1992, respectively. Since 1997, he joined ETRI and has performed many research projects in the area of network system engineering, QoS/TE management, network evolution, service management, network planning, and so on. Currently, he is involved mainly in the design of BcN architecture. His research interests include networking and service architecture, QoS/SLA architecture, and network optimization.

No Ik Park is a senior member of BcN Architecture Team in ETRI, Korea. He received a Ph.D. degree and an M.S. degree from the Sung Kyun Kwan University, Korea in 2000 and 1995, respectively. Since 2000, he joined ETRI and has performed many research projects in the area of network system engineering, QoS/TE management, network evolution, service management, unified AAA architecture, and so on. Currently, he is involved mainly in the design of BcN architecture. His research interests include next generation networking and service architecture, network evolution strategy, AAA architecture, and traffic engineering.

Soon Seok Lee is a team leader of BcN Architecture Team in ETRI, Korea. He received a Ph.D. degree and an M.S. degree from the Sung Kyun Kwan University, Korea in 1990 and 1993, respectively. Since 1993, he joined ETRI and has performed many research projects in the area of network system engineering, performance evaluation, QoS/TE management, network evolution, service management, network planning, and so on. Currently, he is involved mainly in the design of BcN architecture. His research interests include next generation networking and service architecture, network evolution strategy, network optimization, traffic engineering, and network performance evaluation.

Young Sun Kim is director of Network Research Group in ETRI, Korea. He received a Ph.D. degree and an M.S. degree from the Korea University, Korea in 1991 and 1982, respectively. Since 1982, he joined ETRI and has performed many research & development projects in the area of telecommunication network planning, SLA router, BcN Network planning, next generation OSS, and so on. He was a director of Internet technology research group, router system research group, BcN service research group and currently he is a director of Network Research Group. His research interests include BcN networking and service architecture, SLA architecture, and next-generation OSS.

Kyung Pyo Jun received the B.S. degree in industrial engineering from Seoul National University, Seoul, Korea, in 1976, the M.S. degree in industrial engineering from the Korea Advanced Institute of Science and Technology (KAIST), Taejon, Korea, in 1979, and the Ph.D. degree in operations research from the North Carolina State University (NCSU), Raleigh, USA in 1988. Since 1979, he joined the ETRI, he involved in telecommunication network planning, developing the TDX-10 ISDN, advanced intelligent network (AIN) service control point(SCP) for intelligent network services, and communications processing systems for PC communications. He became the executive director of IT R&D Project Division in February 2002. Just before his current position, he contributed to establish optical Internet project and managed system-engineering task of optical Internet project as the director of Optical Networking Department. He is currently leading the broadband convergence network (BcN) Research Division. He is also the chair of the steering committee in the KOIF. His research interests include soft switches, the design of telecommunications networks, Internet traffic measurements, and optical Internet technologies.