

# Meaning and Prospects of IT Convergence Technology in Korea

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## Abstract

With the rapid growth of IT (information technology) and other enabling technologies such as Bio and Nano technologies, there is a growing trend in the convergence of IT in a number of sectors. In this paper, we first describe what IT Convergence is and why important it is, and show some practical cases of IT Convergence to be being implemented in the world. Then, we disclose the essential elements to foster the IT Convergence and explain the convergence industry status and strategies in some developed countries. We also explain the problems encountered in promotion of the IT Convergence industry in Korea. Finally, Korea's future direction and strategy to promote 10 IT Convergence industries is described.

**Keywords:** IT Convergence, Korea's IT Convergence Research Culture, Korea's IT Convergence Strategy, Korea's IT Convergence Areas

## 1 The Nature of IT Convergence Industry

### 1.1 The definition and importance of IT Convergence industry

IT Convergence industry can be defined as a technology leading the social and cultural changes as well as the future economic change by creating new creative value through the synergistic combination between IT and the existing traditional industries or between IT and new technologies such as NT (nano technology), BT (bio technology), CT (cognitive technology), etc.

Some major industrialized countries in the world regard the NT, BT, CT and IT as a mega-trend in modern industry and science especially focusing on the convergence of the NT, BT, CT with IT. USA (the United States of America) considers the synergistic combination of four state-of-the-art technologies such as NT, BT, CT, and IT to be able to improve the human ability to perform [1] and many leading universities in the United States have been restructuring the departments to allow efficient convergence of the life sciences, engineering, medicine, and other natural sciences or operating the centers for the convergence between them.

EU (the European Union) also considers these four technologies and knowledge system of these as a model for the convergence. It predicts a future direction with a wide range of convergence between

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environmental science, systems theory, social science, humanities in addition to the convergence between NT, BT, CT and IT [10].

They prospects that the next-generation industrial revolution will be led by the convergence of the multi-technologies and the convergence between the existing traditional industries and state-of-the art technology like IT rather than by a single new technology [6]. It is expected that convergence will be accomplished in a variety of combinations between the technologies, products, and services. MKE (the Ministry of Knowledge Economy), one of Korean governmental organization, has enacted *Industrial Convergence Promotion Act* for recognizing the convergence technology as a key means to tow the national economy and for accelerating the investment on convergence industries [7].

But the growth of the IT market sustained on the Korean economy since the late 1990s has been slowing down, the strategy to create the new industries based on the existing core technologies and the strategy to preemptively take advantage of the quickening technology should be pursued at the same time in order to strengthen the competitiveness of industry to create new markets. In other words, the efforts should also have to be made to create new markets by combining the world's highest level of IT technologies with other new technologies such as NT, BT and CT.

As a result, it is needed to deploy the strategy to secure new growth engines of the country for the domination in new markets by the intensive investment in R&D that combines commercialization skills into the fast emerging technology [6, 8, 9].

## 1.2 Type and practice of IT Convergence

There can be a several types and practices in IT Convergence. Among them, four of types and practices are introduced as follows.

**IT Convergence between new technologies** Innovative technologies and products to be secured through the state-of-the-art technology convergence between BT, CT, NT, and IT (see Table 1)

**IT Convergence with existing products and new technologies** Increase of the added value of existing products by IT Convergence on existing traditional industrial products and new technologies [3, 2] (see Table 2)

**IT Convergence between new technologies and services** Creation of new value-added service industries by the convergence between the new technologies such as IT, BT, NT and CT (see Table 3).

**IT Convergence between existing products and services** Creation of new value-added services in existing products and services area by the convergence between products, between services and between products and services to correspond consumer demand or due to advances in technology (see Table 4).

On the other hand, IT Convergence brings together various types of applications, such as monitoring system of water environments, recording system of productions history, or tele-diagnosis of animal diseases, etc. IT Convergence also leads to devices designed specifically to replace a number of different electronic items. Mobile phones, for example, have moved far beyond their beginnings as simple voice communication devices and now offer the functionality of digital cameras, personal music players, and text messenger systems. New devices, such as tablet computers, have been developed simply as a format for convergence, while functioning all features in the place of numerous earlier electronic appliances. It is highly expected that IT Convergence accelerates the deployment of such new type of applications and devices.

## 2 Analysis of the Internal Capabilities and Key Issues in IT Convergence

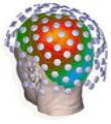

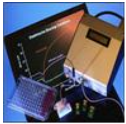

### 2.1 Status to promote IT Convergence in the major industrialized countries

USA is conducting a strategy called *NBIC<sup>1</sup> Converging Technology* by leading of NSF (National Science Foundation) with an idea that it should be studied with the convergence of those four technologies, NT, BT, CT and IT, for the future science and technology from the early stages. Six USA convergence technologies of which four are related to life science field are listed as follows:

1. Information and Computing
2. Nanoscale science and engineering
3. Medical sciences and enhancement of human physical capabilities
4. Biology and bioenvironmental approaches
5. Cognitive science and enhancement of intellectual abilities
6. Collective behavior and systems approaches




From 2008, USA has been performing a business project for convergence R&D based on IT, NT, BT, materials while investing 1.45 billion USD (about 1.7 trillion Won) in NNI budget. NSF also intensively

Table 1: IT Convergence between new technologies

Convergence Type	Instance		Contents
BT+CT+IT		BMI (Brain Machine Interface)	- The improvement of the life and health of human utilizing the technology to express the the human will by the brain and the machine (computer) connection (e.g., the idea inherent in the computer to overcome a variety of body and cranial nerve disorders)
BT+IT		Bio-informatics	- Analysis and research of the biological meaning for the genomic information of human and all living things on earth (e.g., to take advantage of in a personalized medicine and the industrialization of the organism)
BT+NT+IT		Bio-signal measurement	- Product development to measure or adjust the signals using the nano-technology (e.g., to develop technology to detect biological material at the molecular level and fast or accurate diagnosis using nano-structures)
CT+IT		Virtual Reality	- Technology to make the people who use it recognize that they interact specific situation or a virtual person (e.g., flight training simulation and indoor screen golf)

<sup>1</sup>It stands for Nanotechnology, Biotechnology, Information technology and Cognitive science

Table 2: IT Convergence with existing products and new technologies




Convergence Type	Instance	Contents
Automotive +IT		<p>Smart Car with the function of recognition of driving situations</p> <ul style="list-style-type: none"> <li>- Real-time self-diagnosis, provision of information, critical alarm on driving situations, induction for active safety driving based on the information collected by sensors for infrastructure, the vehicle status, surround detections (e.g., radar, imaging, ultrasound, etc.)</li> <li>- 80% in car area already implemented by IT or SW technology</li> </ul>
Ship+IT		<p>Digital Ship</p> <ul style="list-style-type: none"> <li>- Combining of IT with facilities and equipment related to the design, construction, and operation for the maintenance of the ship</li> <li>- Performance enhancements of the ship and improvement of the productivity of the shipyard</li> </ul>
Clothing +NT+IT		<p>Smart Clothing</p> <ul style="list-style-type: none"> <li>- A new concept of clothing with advanced digital features (e.g., MP3 player, LED, etc.) while maintaining the general texture of the fabric</li> <li>- Cloths performing the various function to transmit the electrical signal using a special material or computer chips or exchanging the data with external digital devices</li> </ul>

invested for health field such as healthcare, bio-chips, bio-informatics, etc., by putting 29 billion USD in 2008.

EU has established *Convergence technology development strategy for the construction of a knowledge society* in 2004. EU members have considered that the social and cultural impact of the convergence of technologies as well as economic aspects is important. EU has been trying to concrete the convergence technology through the *7th Framework Programme 2007~2013*, the EU research and development project, which will be progressed until 2013 and they have set up a plan to invest 11.62 billion Euros (about 17.5 trillion Won) in order to expand the development of convergence technology by 2013. In addition, major companies such as Philips, Siemens, ST micro-Ile-Tronics are focusing to invest intensively in their health care, bio-informatics, lab-on-a-chip, etc. Major areas for convergence technology development in the 7th Framework Programme 2007~2013 in EU are health, education, information and communication infrastructure, the environment, and energy.

Through the *New Industry Creation Strategy ('04)*, Japan is pursuing a policy to create the new convergence industries such as content, healthcare, and business support services. It presented seven high-tech industries and policy challenges for the international competitiveness, social demand response, and the region activation. They also began to support convergence technology with *A Third Science and Technology Basic Plan ('06~'10)* for the creation of new markets. In addition, major companies such as Hitachi, Fujitsu, NEC, and Toshiba have focused intensively to invest in bio-informatics, health care, and the development of new drugs. Seven strategic industries in Japan are fuel cells, information electronics,

Table 3: IT Convergence between new technologies and services

Convergence Type	Instance		Contents
IT+Medical Services		U-Healthcare /Smartcare	- Real-time management services for the patients enabling the tele-medicine by combining the medical service and IT technology
Robot +Medical Services		Surgical Robot	- Robots to assist the surgery or to act as a guide for surgery according to the command of the surgeon in the operating room by combining the robot technology and medical services - Instead of doctor, the surgical procedure is performed in whole or in part
IT+Logistics /Distribution Services		Intelligent Logistics	- Real-time determination of the location of the objects by combining electronic communication technology and logistics and distribution services - Technologies to minimize the cost and loss for the shipping goods

robotics, contents, health and welfare, environment and energy, and business support services.

## 2.2 IT Convergence technology status and problems in Korea




Despite the endeavour for the convergence of IT and core industries, the convergence technology in Korea is in early stage as a whole compared to the developed countries. A few problems in the promotion of the Korean IT Convergence industry are as follows.

First, the government was trying to establish the government-wide level convergence technology development plan since 2008 [4, 5] and has also announced the implementation plan for convergence annually and tried to respond preemptively, but it was a bit late than the major industrialized countries. For the success of convergence, the communication between the various professional major areas was essential, but these efforts of the domestic researchers were too lack. In case of government support for R&D, many individual researches were mainly being carried out and the support for the convergence field which is essential for joint research studies between interdisciplinary or parties was minimal or was formal.

Second, it was being propelled to develop convergence technology and to create new industries by the government departments without a national level strategy or the national level control tower. Therefore, there was no linking between technologies, products, services in the governmental support for the IT Convergence industry promotion, accordingly there was no enough synergy effect of it. Also the convergence between products and between product and service was not active since most researchers focused only to the unit function developments (i.e., mostly the simple technology development for a specific area).

Third, there were many constraints in the creation of new market by IT convergence as well as the delay of commercialization for developed products due to the absence of the legal basis and institutions

Table 4: IT Convergence between existing products and services

Convergence Type	Instance		Contents
Cellular Phone+ Services		Smart Phones	- Convergence of the variety of the application contents services into a single business model for the cellular phones and multi-media (MP3 player, camera, etc.).
TV+Services		Internet TV (IPTV)	- Convergence service of the broadcasting and communications
Services +Services		Medical +Tourism	- Providing a new services through a combination of medical and tourism.

for the activation of IT Convergence industry. To solve this problem, the Ministry of Knowledge Economy (MKE) enacted *Industrial Convergence Promotion Act* in 2011, but its effectiveness is not measured yet.

Fourth, the professionals for research of IT Convergence were too lack in terms of quantity and quality. Therefore, some universities like Seoul National University (department of nano technology), Konkuk University (department of convergence technology), and Sungkyunkwan University (Samsung academia collaboration courses) have been trying to attempt to bringing up the creative talented people for the IT Convergence but the visible achievement of it was not insufficient because of the problems like the lack of the dedicated professors, the absence of convergence textbooks, the barriers between professors and the non-cooperation of the existing departments. It was very difficult to realize IT Convergence unless the department operation system or professor culture in the current universities is improved. It was also because of that the definition of the convergence was vague or the business goal to gain through the convergence was not setup clearly.

### 3 Strategy to Foster IT Convergence Industry

#### 3.1 Financial Strategy

The R&D in the field of IT Convergence industry has a number of experimental attempts and there are many high risk projects which have a high probability of failure. Therefore, the active initiative or intervention of government is desirable. In Korea, however, as the scale of R&D budgets is not big and the tolerance against the failure in experimental projects is low, it is difficult to get the funding for IT Convergence R&D. It is definitely needed to introduce the creative financial policy that can activate the IT Convergence projects.

In case of that the technology-driven future value-oriented companies is trying to be listed on KOS-

DAQ, there already exists a preference system to exclude or relieve the listing requirements that venture company is difficult to meet. In situations where the government cannot support all stages of the R&D, these policies are very meaningful in the aspect of that it makes the way to prepare the fund to the technology-driven companies. As KOSDAQ keeps a very conservative attitude in the implementation of this policy, however, the number of companies which got technical exemption benefits was small over the past five years. If KOSDAQ does not take the good intention of the system actively, the IT Convergence sector continues to rely on government funding or the research results that the government already invested will lead to get buried. By taking the original intent of the technology exemption, the government and its institutions should aggressively support the IT Convergence venture companies to do IPO (Initial Public Offering) and with this, the link between the government fund and the private capital is needed to be built.

China still has a lot of vulnerable industries in the high-tech sector. Especially, Korea has many technologies and products that can be supplied to China in the areas such as biotechnology, health, design, robotic technologies, etc. Therefore, it is necessary to construct the system and the environment to actively promote the introduction of China fund, M&A with Chinese companies, out-licensing, and co-development.

The venture capital firms which led the prosperity of the start-up company in USA from 1990 are now struggling to find out the worthy investors in domestic because of the recent economic downturn in the U.S. market. Venture capital firms are trying to shop for investment in emerging countries in Asia which continue to grow high. Those investors in emerging countries are also favourable to invest in Korean market which has a good system for the protection of IPR (Intellectual Property Rights) and good infrastructures compared to other developing countries such as India and China. Considering these circumstances, it is needed to introduce their capital aggressively into the Korean domestic market and Korea needs to grow the venture businesses in domestic IT Convergence venture companies.

In contrary, some of venture companies in USA and Japan feel thirsty to get the fund due to the global financial crisis. These companies have been mostly founded based on the corporate performance or especially the core technology by the large scale of R&D funding from their own government. By trying to introduce them to Korean IPO markets, it is needed to increase the accessibility of the Korean companies to core technology of the developed countries. Korea needs to review carefully this method to get the high performance skill for the business as well as the R&D for IT Convergence as a way to introduce the high technology companies in the world into Korea.

### **3.2 Efforts for IT Convergence research culture**

As IT Convergence industry is an industry to create new technology, new products, new services by combining the science and technology in the various fields, it is essential to joint research between research members in different fields. But Korea has very difficult environment to joint research with other fields.

In the case of the university, it is operating by department-centric and is composed with the environment to contain mutually having a fierce competition to secure the student garden, budget and lab space rather than having a productive communications. Even in the case of R&D institutes, it is also difficult to involve in the long-term and high risk convergence projects because it relies to external funding in a large part due to the PBS (Project Based System : Researcher can survive only in case of getting the budget from the government, companies, or the R&D institutes).

The university system is needed to reorganize that each department is not an administration unit only to manage. It is needed a way to give an incentive when they develop the convergence curriculum, open the convergence experiment curriculum, and research convergence items in order to encourage the convergence research. Affiliated institutes need to construct the infrastructure that can design and

perform high risk long-term projects and thus there is a need to develop the new evaluation system and R&D performance indicators for the commercialization and business while moving away from the evaluation of paper-centric presentation which is pedantic and impractical.

Even though it is needed a control tower to handle overall R&D of IT Convergence, there are many cases to be performed individually for the IT Convergence research and developments only in order to get the fund by the researchers gathered formally from the heterogeneous sectors. For the convergence in various areas, there is a need to design the convergence R&D at the organization with scientists, technicians, business people who have a keen insights to the future direction for convergence and have a good understanding to the science, technology and industry at the same time.

### 3.3 Open Innovation

There is a need to actively pursue open innovation to bridge the technology gap in a short period of time, and to create new markets as the domestic IT Convergence technologies are in a lower level compared to major industrialized countries such as the United States, Japan, and EU.

Domestic researchers have very strong desire to carry out a state-of-the-art technology type project from the first time by themselves. But given that the size of the domestic fund and a bit difficulty environment to joint work, this way of R&D in almost all cases performed in fail and this phenomenon is being repeated.

In the early stage of research and development, the strategy to raise the value of open innovation through the quick introduction of the core technologies from the developed countries into the domestic science and technology is now required for the university and affiliated institutes as well as the companies. The intention of domestic firms to acquire the external technology and the execution ability is insufficient while the global companies pay a great deal of effort to secure external technology through direct investment, joint venture, M&A, and technology transfer. Therefore, the new idea is required in order to activate the exchange and introduction of technology with advanced corporates or research institutions.

### 3.4 Improvement of law and institutions

In Korea, there are many things to constrain the creation of new markets for IT Convergence due to the limitations in the existing laws and regulations. Also, there appears to be response to rapidly changing market conditions, and the demand of the related legislation for IT Convergence industries is surging. To solve this problem, the Ministry of Knowledge Economy (MKE) enacted to promote *Industrial Convergence Promotion* and it is expected to extend the institutional foundations based on IT Convergence.

The construction of a mechanism that can resolve rapidly the problem is needed because there have been a delay for new products to go to the market because of the existing regulations or lack of regulations. Due to the characteristics of the IT Convergence products which are combined with the various technologies and products, fast resolution is more required. Therefore, the government is required to introduce *Temporary Certification Scheme (Fast-Track)* for seamless launching of the new IT Convergence products.

## 4 Fostering The Base Fields for IT Convergence Development

In order to foster the IT Convergence industry successfully, the design and knowledge service should be essentially considered as the link with the IT Convergence products and technologies developed to activate them in the market and create the sizable amount of employment.



#### 4.1 Design - public design, concept design, service design

It is important to develop the user-friendly products by utilizing the high-level design preemptively. The products and services that appeal to consumers' emotion and experience began to occupy the important portion in industry and the role of design is becoming increasingly important. The design can be classified in public design, concept design, service design.

First, the preemptive preceding design in the development of products and services is important and it promotes the convenience of the user and improves the functionality. Second, service design is to promote configuration and array of products and services so that the consumers that use the products and services can have a sense of positive empathy in the entire process from the first face-to-face to the last moment. Third, the public design is to solve the problems in public realm such as environment, energy, security, aging, education, health care, and public administration in order to solve the social issues using design technology.

#### 4.2 Knowledge service

Because the diversity of the industry is expanding and the expertise is deepening day by day, it is needed to build an expertise service system in each sector systematically in order to respond the situation preemptively.

The knowledge service industry is one of B2B industries and support the increase for the productivity and efficiency of the other industries (traditional industries, knowledge-based industries, and service industries).

In the aspect of the convergence industry, knowledge services have a role that actually leads to the convergence of various fields. For example, it is expected to have a great role in the area of research to survey and analyze the market and the flow of the future industries proactively, in the development of business model to be formed through the convergence of various industries, and in the area of promotion and marketing of new products and services.

Korea is vulnerable in the IT Convergence industry and is needed to bring up strategically the service R&D. For example, the various knowledge are needed for IT Convergence companies to pass the permit requirements that the developed countries require in order to enter the pharmaceutical market in advanced countries. It is also needed to promote the expert CRO (Clinical Research Organization) business companies. By strengthening the knowledge service to participate in the national R&D process of all stages of R&D such as technology development, product development, and business model development, it should be maximized the possibility for achieving of business profitability. Convergence

### 5 10 Areas of IT Convergence and Strategy

Korean government has setup a plan and strategy to foster the 10 areas of IT Convergence through *The 2nd IT Convergence Expansion Strategy* in September, 2012. The plan's goals are to 1) secure the new growth engine of industries and 2) improve the quality of people life dramatically through the expansion of IT Convergence [9]. Through these, it will be secured the stable growth base to correspond and overcome uncertainty in worldwide economic crisis and low growth atmosphere.

The 10 areas of IT Convergence are categorized with two groups; Core industries IT Convergence and IT Convergence services (see Fig. 1).

The 1st group of IT Convergence is targeting to raise the competitiveness of traditional industries combining with IT technology and get the value-added products and technologies. Those Core industries IT Convergence are as follows: Automobile IT, Ship•Ocean Plant IT, Textile IT, Defense•Aerospace IT, and Energy IT.

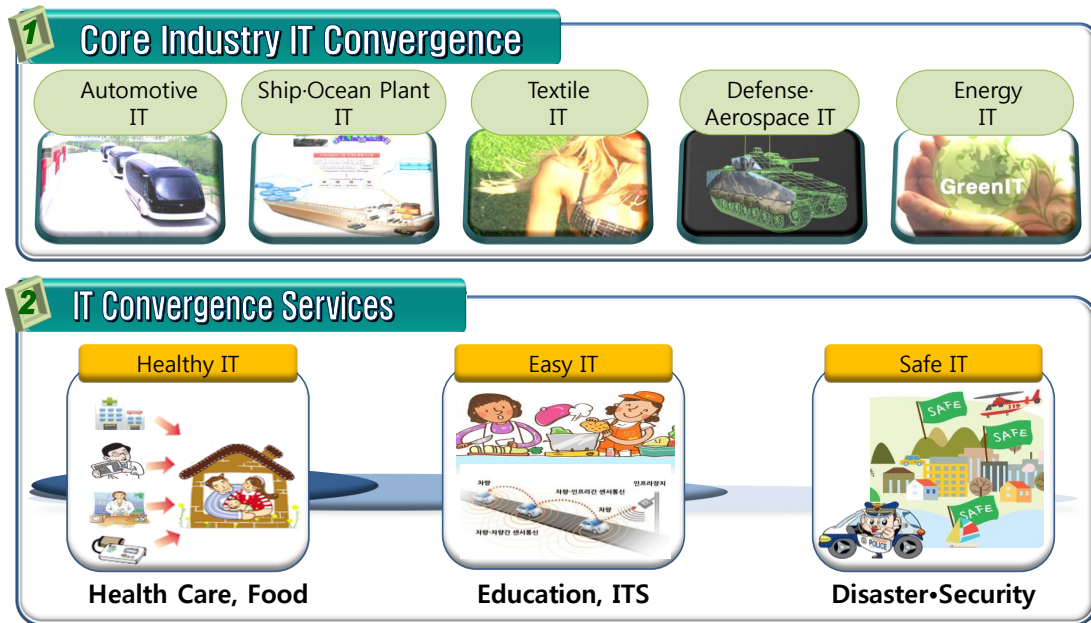


Figure 1: The 10 areas of IT Convergence

Another group targets to solve the social issues and secures the people's happiness. And those industries can have a high possibility to be linked to the service to perform after the development of the products and technologies. Those 2nd group of IT Convergence consists of 1) Healthy IT (e.g., Health Care, Food and Agriculture), Easy IT (e.g., Education and ITS (Intelligent Transportation System)) and 3) Safe IT (e.g., Disaster and Security to provide healthy, easy and safe life to the people) [9].

In order to drive smoothly to foster those 10 IT Convergence areas, the government will try to prepare the system to solve the institutional limitations and also try to create the new markets. It will also try to secure the initiatives for international standards for the IT Convergence products and technologies as well as to put a full effort to bringing up the excellent manpower for IT Convergence.

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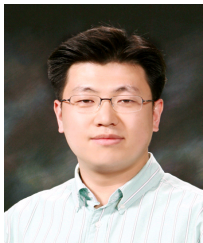
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## Author Biography



**Sang Cheol Han** is a National R&D Program Director (PD) for IT Convergence at Korea Evaluation Institute of Industrial Technology (KEIT) under the umbrella of Ministry of Knowledge and Economy (MKE). After the graduation of Kyung-pook National University in 1982, he had worked in ETRI until 1994 to develop the CDMA Basestation Transceiver System (BTS) then worked for Shinsegi Telecom (that had been merged to SKT) for about 5 years, while having roles of the development of mobile terminals and deployment of the CDMA network and wireless data services.

Then he had worked at Pantech as a Vice President for GSM/GPRS mobile phone developments, also charged in Overseas Sales and Strategic Procurement. Han received his Ph.D. in Digital Communications in 2004 from the University of Yonsei in Seoul and his research specialty was in the field of wired/wireless communications. He is a first man in the world who has been given a opportunity to develop the small-sized BTS like pico and femto BTS as he has developed CDMA Micro-BTS in 1996 for the first time in the world. Since 2009, he has been devoting in supporting enterprises, universities and R&D institutes working at the governmental organizations (Daejeon Technopark and KEIT) to come up with the more added-value on the existing industries and to create new market in IT Convergence area. For R&D planning for IT convergence technology development, he is also working very closely with governmental officers.



**Youn-Hee Han** received his B.S. degree in Mathematics from Korea University, Seoul, Korea, in 1996. He received his M.S. and Ph.D. degrees in Computer Science and Engineering from Korea University in 1998 and 2002, respectively. From March 4, 2002 to February 28, 2006, he was a senior researcher in the Next Generation Network Group of Samsung Advanced Institute of Technology. Since March 2, 2006, he has been a Professor in the School of Computer Science and Engineering at Korea University of Technology and Education, CheonAn, Korea. His primary research interests

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