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IT Road Map toward 2010

Hideaki NAKAMOTO and Masatoshi KOMEICHI

Nomura Research Institute

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With the rapid development of information and communications technology, the environment surrounding broadband networks (high-speed, large-capacity circuits), mobile communications and other related technologies has also been changing at a rapid pace. In order for a business enterprise to make a suitable IT (information technology) investment under such circumstances, it must be able to forecast the trends of significant technologies that will become available in the future and map out a technical strategy based on such a forecast. Since 2001, Nomura Research Institute (NRI) has continuously been conducting research on IT trends, making forecasts and creating the "IT Road Map."

The development of information and communications technology is ushering in an era of the ubiquitous network that enables access to a network "at any time, anywhere and by anything." In the early years of the 2000s, progress was made in the development of infrastructure for the ubiquitous network. What will become increasingly important as we move toward 2010 is how best to utilize the massive amounts of information that can be obtained by connecting networks with the wide variety of terminals and sensors that will emerge in the future.

Information systems that will be built around 2010 will establish "precise real-world models" based on information obtained from "a vast amount of network devices," and offer carefully tailored services. These information systems will also realize "intelligent information processing" such as supporting human decision making and automating advanced information processing.

I IT Evolution and IT Road Map

1 Changes in the IT Environment

Information systems and IT (information technology) have become essential for the implementation of business activities in companies. Information systems that simply pursued streamlining have been developed into those that assume an important role as a vital element of business itself. A typical example is the use of the Internet for electronic commerce. A survey conducted by the Japan Securities Dealers Association revealed that the turnover from stock transactions via the Internet reached 67 trillion yen in the second half of fiscal 2004, which accounted for approximately one-fourth of the total stock brokerage amount by securities firms.

The evolution of IT has been a major contributor to the popularization of information systems. For example, striking achievements have been made in developing faster and more compact computers as well as faster networks. In addition, one of the recent features of IT is its remarkable diversification. Taking terminals as an example, a wide variety of devices are now being used such as mobile phones and IC (integrated circuit) cards and their readers as well as PCs. For home-based Internet access, an array of options is available including CATV (cable TV), ADSL (asymmetric digital subscriber line), optical fiber networks, wireless links, etc.

Because a number of vendors are providing diverse types of similar products, the information system department of each company must establish a policy of which products are to be applied by identifying the salient features of individual IT products.

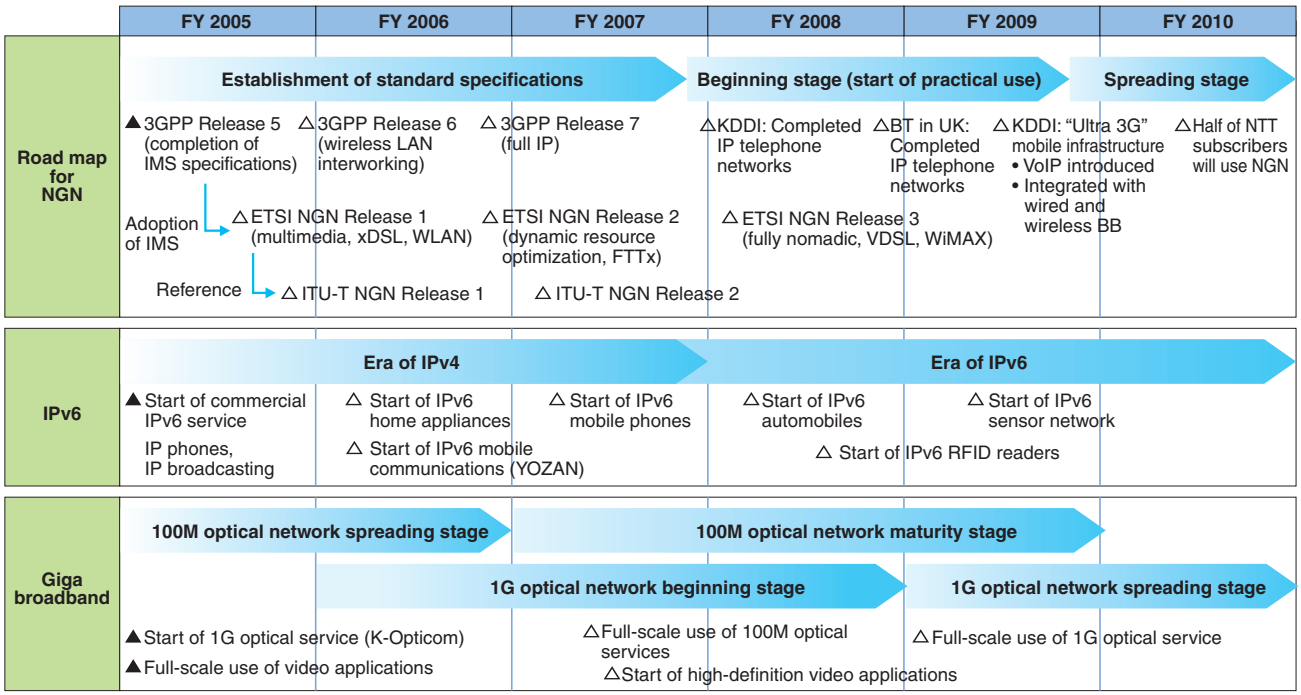
2 IT Road Map

The Information Technology Research Department of Nomura Research Institute (NRI) is taking surveys and making forecasts of the constantly evolving IT trends, and is preparing the "IT Road Map" based on these surveys and forecasts.

The "IT Road Map" forecasts the trends in technology development from now for approximately the next five years with respect to a specific IT field. If a new technology is expected to emerge that can replace the current technology in a specific field, the road map will articulate such timing. In particular, if emerging technology is expected to have a major impact on the business environment, proposals will be made on the concept of new businesses. The IT Road Map is designed to support companies in their study of when and what technology requires examination for its introduction.

For example, the road map for wired communications technology is shown in Figure 1. In preparing the IT Road Map, we conduct extensive research on domestic and overseas R&D trends, activities of standardization organizations, products developed by venture firms,

Figure 1. Road Map for Wired Communications Technology



Notes: (1) 3G = third generation, 3GPP = 3rd Generation Partnership Project, BB = broadband, BT = British Telecommunications, ETSI = European Telecommunications Standards Institute, FTTx = fiber-to-the-x (optical fiber broadband systems), G = Gbps (gigabit per second), IMS = IP multimedia subsystem, IP = Internet protocol, IPv4 = IP version 4, IPv6 = IP version 6, ITU-T = Telecommunication Standardization Sector of the International Telecommunication Union, LAN = local area network, M = Mbps (megabit per second), NGN = next generation network, RFID = radio frequency identification, VDSL = very-high-data-rate digital subscriber line, VoIP = voice over IP, WiMAX = worldwide interoperability for microwave access (high-speed wireless communications technology), WLAN = wireless LAN, xDSL = (general term for) digital subscriber line. (2) "Fully nomadic" means that a mobile terminal can be used in different network domains.

trends of product developments by major companies in a specific field, etc. The assessments of IT analysts based on their expertise are added to the results of these research activities in compiling these reports.

This paper introduces the outline of the technologies that are expected to lead to major innovations in businesses and society in the next five years through 2010. This paper also discusses how such technologies can be applied by introducing cases in which such technologies have recently appeared. Toyo Keizai has published a book entitled *2010 nen no IT rodo mappu* (IT Road Map to 2010). This book provides the details of these technologies for anyone who is interested.

II IT in 2010

Spurred on by the development of information and communications technology, the era of the ubiquitous network is about to emerge where access to a network can be made "at any time, anywhere and by anything." In the early years of the 2000s, the infrastructure of the ubiquitous network was developed, and great progress was made in network technology centered on broadband capabilities (high-speed, large-capacity circuits). As we move toward 2010, major themes will include how to connect the vast variety of terminals and sensors emerging in the future to a network and how best to use the enormous amount of information that will become available through such a network.

The following section presents an overall picture of IT in 2010 in four fields of devices including terminals and sensors, networks, the development of information systems and information technology for utilization.

1 Increases in Network Devices

The largest innovation in the device field is the connection of a great number of devices other than personal computers (PCs) to a network. These devices include digital information appliances such as DVD (digital versatile disk) recorders and portable digital audio players, RFID (radio frequency identification) tags and sensors (Figure 2).

It should be noted that unlike PCs and mobile phones, which have so far been typical network access devices, RFID tags and sensors are not intended for communication between people. The objective of connecting these devices to a network is to provide services for consumers by utilizing the information acquired through such devices and to use such information as input in enterprise information systems.

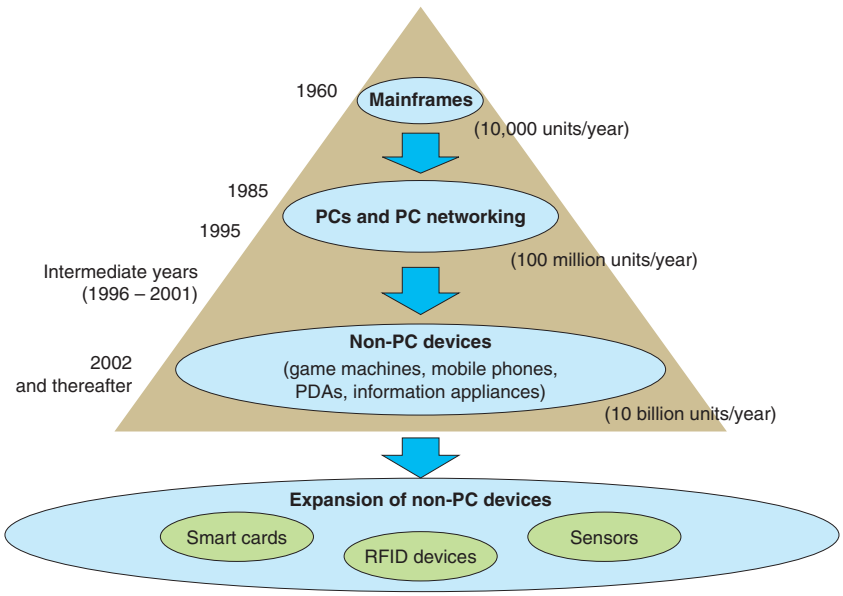
(1) Network-connected digital information appliances

Digital information appliances such as DVD recorders and portable digital audio players are gaining in popularity. A home network connecting such AV (audio video) devices is projected to emerge during fiscal 2006. In 2007 and subsequent years, electric home appliances such as refrigerators and washing machines will also be connected to a network to monitor their operating status and to update the software controlling the appliances.

(2) Real RFID utilization

Around 2010, a variety of attributes such as temperature, velocity and pressure will become the subject of sensing via networks. Among others, great expectations

Figure 2. Expansion of Non-PC Terminal Devices



Notes: (1) The years shown at left are the approximate starting years. The numbers in parentheses represent the world demand for terminal device units. (2) IC = integrated circuit, PC = personal computer, PDA = personal digital assistant.
Source: Compiled based on *Ubikitasu nettowaku to shijo sozo* (Ubiquitous Network and Market Creation), NRI, 2002.

are being given to the sensing of IDs that will be used extensively in businesses and everyday life. This ID is information that identifies a person or thing.

A typical example of a sensing device that identifies a person is a smart card. Smart cards have already been widely applied for transportation tickets and bank cash cards.

An example of a device to identify an article is an RFID tag. This is a small IC chip, and contains and transmits ID information such as a product code by radio waves. A sensor receives this transmission. In the United States and Europe, major retail companies have already introduced RFID tags for managing product inventory. In 2005, the EPC (electric product code) data format and middleware specifications were established. In Japan as well, RFID tags will be used for order processing and inventory control from around 2007 to improve the efficiency of such operations.

2 Completing a Network Connecting a Variety of Devices

Recent increases in network speeds can be expressed as spectacular. Over the past ten years, the transmission speed of Ethernet, which is the typical example of the LANs (local area networks) used for intra-networks has become 100 times faster. Broadband services are increasingly being used for Internet access. In June 2005, the number of subscribers to broadband services such as ADSL exceeded 20 million, and the rate of household penetration reached 44 percent.

By 2005, broadband-related technologies have generally been developed in the field of information and communications technology. During the next phase, the technology to realize the ubiquitous network will be practically applied.

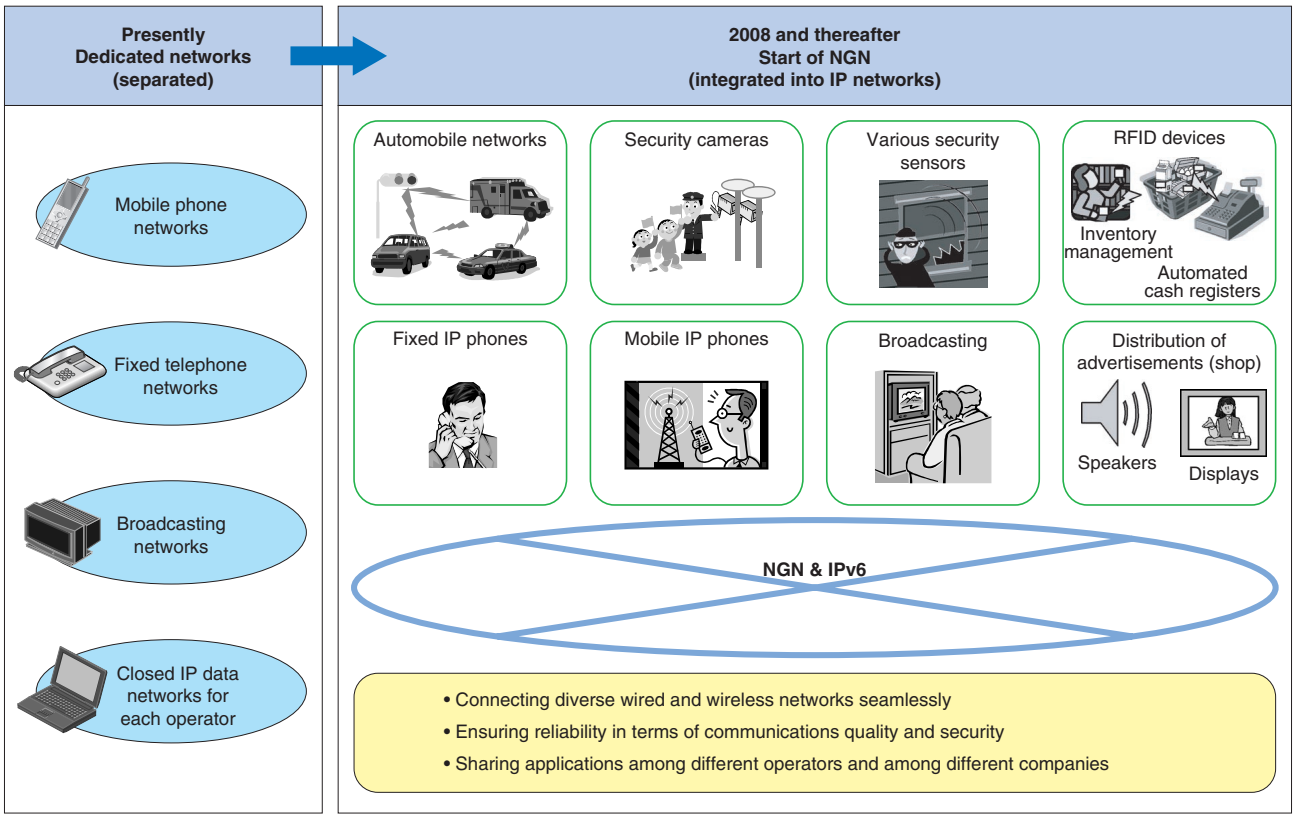
This paper examines the following three technologies worthy of attention in the network field: (1) Ipv6 (IP Version 6) technology to connect a large number of devices such as 20,000 – 30,000 to 200,000 – 300,000 devices to an IP (Internet protocol) network; (2) NGNs (next-generation networks) to use networks separated for each usage purpose such as mobile phone networks and the Internet on a seamless basis; and (3) high-speed wireless technology exceeding 100 Mbps (megabits/second).

(1) Spread of IPv6

Some communications operators have already provided consumers with commercial services using IPv6, which is the next-generation Internet protocol. Around 2009, a full-scale migration will take place from the current standard IPv4.

IPv6 allocates a 128-bit length to an address (IP address) to identify a device connected to a network. In a rough calculation, this means the connection of a huge number of devices, or the number obtained by multiplying 4.3 billion four times. Practically speaking, an almost infinite number of devices can be connected to the Internet.

Figure 3. Integration into IP Networks by NGN



Furthermore, the functions to facilitate device-to-device communication are added in Ipv6. These include automatic address setup, security functions such as authentication and encryption, QoS (quality of service) functions to guarantee the quality of communications and multicast (data transmission to designated multiple parties) functions to deliver voice and video signals efficiently.

(2) Realization of NGN

NGN is a new network standard that integrates telephone and data communications by means of IP. Currently, the ITU-T (the International Telecommunication Union; the Telecommunication Standardization Sector) is engaged in standardization activities for this new technology. Standard specifications under consideration include providing extensive multimedia services, guaranteeing quality of service and assuring connectivity with existing networks. ITU-T plans to establish major NGN-related standards by 2007. From around 2008, a next-generation network conforming to these standard specifications will be used on a full-scale basis (Figure 3).

NGN is expected to provide seamless and high-quality communications services. At the same time, existing networks will also be used in parallel with NGN depending on the usage purposes in consideration of the quality required and cost requirements.

(3) Wireless technology offering increasingly higher speeds

The representative example of wireless technology that is now widely used is the mobile phone. The ITU-R (the Radiocommunication Sector) is currently examining the specifications of the fourth-generation mobile phones with the aim of commercializing such technology around 2010. Accordingly, fourth-generation mobile phone service capable of communications at 100 Mbps will make its appearance after 2010.

In the wireless LAN field as well, the standard specifications for IEEE802.11n (the wireless LAN standard established by IEEE; IEEE = Institute of Electrical and Electronics Engineers) that will achieve performance exceeding 100 Mbps are to be established in 2007. In fiscal 2007 or 2008, IEEE802.11n will be practically applied.

Furthermore, technology to automatically switch a mobile phone and a wireless LAN system according to location will also become available, further improving the convenience of radio communications.

3 Trends toward Loosely Coupled Information Systems

In addition to the environment of information and communications technology such as broadband and mobile communications, company environments are also rapidly changing. In order to deal with such changes flexibly and promptly at low costs, the technology to develop an information system is also evolving.

(1) IT resources are becoming utilities

The development of the network technology as represented by the Internet started to have a major impact on computer architecture. The technology of parallel computers that execute astronomical numbers of scientific and technological calculations by connecting multiple computers has been available for more than ten years. However, recent trends toward increasingly higher-speed networks have enabled realization of grid computing technology where multiple computers distributed throughout wide areas are connected by a network and are used as if they were a single super computer.

With the realization of the ubiquitous network, an enormous volume of data will be created by a variety of information devices. To process such data, computer centers will require servers with increasingly higher-performance. Moreover, rapid increases in data volume frequently occur in information systems that consumers directly access for electronic commerce, transactions via the Internet, etc. Under the current framework, it is difficult to quickly handle these fluctuations, and any attempt to deal with such fluctuations will increase costs. Accordingly, growing expectations are being given to grid computing as the technology to resolve such issues.

Grid computing positions processing power as a utility in a manner similar to electricity and water, and makes such processing power easily available whenever necessary. However, applying this technology to businesses requires standardization and the resolution of security issues. At present, some standardization organizations including the Global Grid Forum (GGF) are conducting activities for these purposes. Because many issues remain to be resolved, grid computing is expected to be fully employed for practical applications after 2009.

However, once the issues such as standardization are resolved, it will become possible to flexibly procure processing power from anywhere in the world.

(2) SOA will change the development of application software

In 2010, the development of applications using SOA (service-oriented architecture) will become commonplace. SOA refers to an architecture where applications or some functions of applications are used as common "services" or components. These components are combined as necessary to develop a new system.

Substantial portions of applications that have been developed based on SOA can be reused as services, and new applications will be developed by combining such services. Any change that occurs in business can be dealt with flexibly and promptly at low costs by reusing and/or rearranging services.

As concepts designed for reusing software components, component-oriented and object-oriented approaches have so far been proposed. The difference between SOA and these approaches is the granularity (unit) of components. The granularity of software components (i.e. services) that are reused under SOA is larger than that of component-oriented and object-oriented approaches. Examples include "inventory search services," "ordering services" and "payment services." Another point worthy of note is that software components can be reused by transcending organizational boundaries, such as between companies, without being confined to a single program or within a single organization.

Applications created in conformity with the concept of SOA are called composite applications. These applications combine multiple services to function as a single system.

4 Realizing Advanced Utilization of Information

Massive amounts of information are stored in networks and enterprise information systems. Such information is distributed among a number of systems, and its format widely varies such as numerical data, documents, voice and images. With the progress of the ubiquitous network, diverse sensors connected to networks will continuously create vast amounts of data and information.

In the future, how to efficiently use such information will become a critical factor. Many consumers have already begun using search engines to select needed information from the massive amounts of information available on the Internet and utilizing selected information for shopping, etc.

However, it has not been easy to efficiently use diverse data stored in distributed systems. Accordingly, the technology required to meet the needs for advanced information utilization will become available in the future (Figure 4).

(1) Evolution of information retrieval technology

The first stage of the evolution of information retrieval technology involves the expansion of the data subject to search. It will become possible to search data on a seamless basis whether the data is information on websites or data stored in databases.

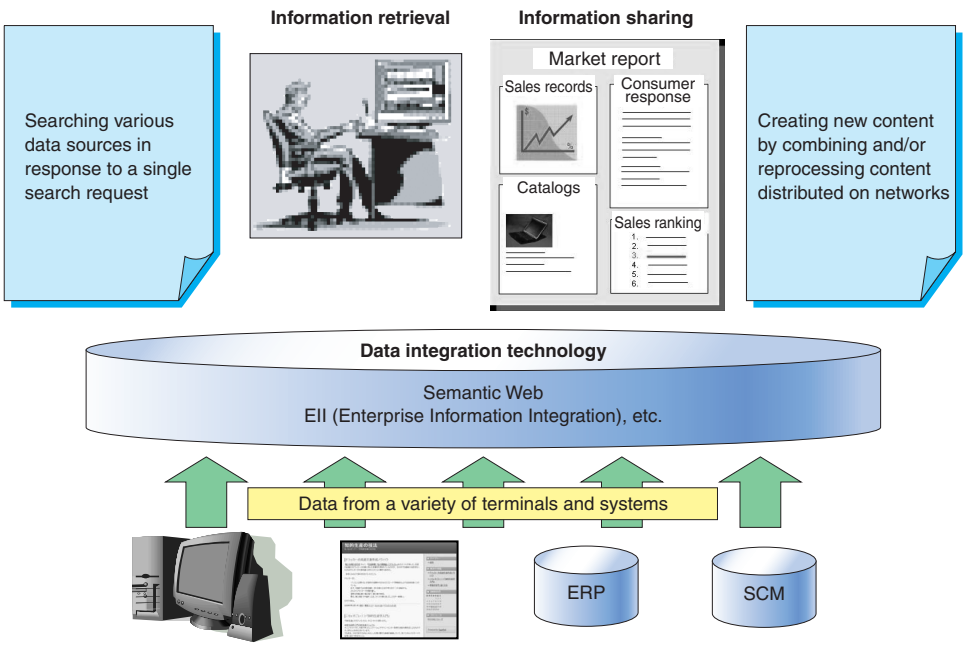
In a company, data are distributed among intranets, groupware, file servers, databases, etc. In the past, it was necessary to use separate search functions to retrieve the data stored in each of them. The search software for enterprises that is currently available can collectively search data stored in multiple devices via a single search.

In the future, in addition to a passive response of simply meeting the search request of a user, active intelligent information retrieval support systems will become available, in which the search results are customized according to the past search behavior of the user, and relevant information will be searched automatically and displayed when the user is working on a PC.

(2) Semantic Web—emergence of technology to process the semantics of data

Research is now underway on technology for the Semantic Web in order to utilize a variety of data such as web content and e-mail in addition to transaction data and product data, which have been managed by computers in the past. Under this technology, a meaning is

Figure 4. Advancing Information Technology for Utilization



Notes: ERP = enterprise resource planning, SCM = supply chain management.

assigned to an individual data item, and such meanings are directly "understood" by a computer.

Although large costs are currently incurred in this process because a person must actually assign a meaning to each item of data, substantial advantages can be obtained. After 2010, links can be autonomically established between information systems and devices by applying Semantic Web technology. Furthermore, in establishing links between applications, the Semantic Web technology can also be used to automatically combine services.

(3) Progress in content utilization technology —realization of web content linkage

From around 2004, the unprecedented mechanisms of information origination and information distribution have emerged, such as "blogs" (simple diary-like websites) and "RSS fields" (RSS is the standard to distribute update information for websites).

To date, these mechanisms are simply recognized as free services on the Internet. However, because these mechanisms contain infrastructural technology capable of transforming information distribution via the web in the future, they will have an impact on the existing methods of information sharing and enterprise applications such as groupware, e-mail, EIPs (enterprise information portals), etc. Such changes will be triggered by the spread of metadata technology and the establishment of specifications using web services enabling the manipulation of content via the web.

This will enable the combination and reprocessing of content distributed on the web. The web world where it is possible to distribute and reuse information is considered an upgraded version from the times when the functions available were confined to only those that displayed conventional HTML (hyper text markup language). This new world has been called "Web 2.0." The meaning of the concept of information sharing will be changed from the level of "viewing information together" to the level of "utilizing information together."

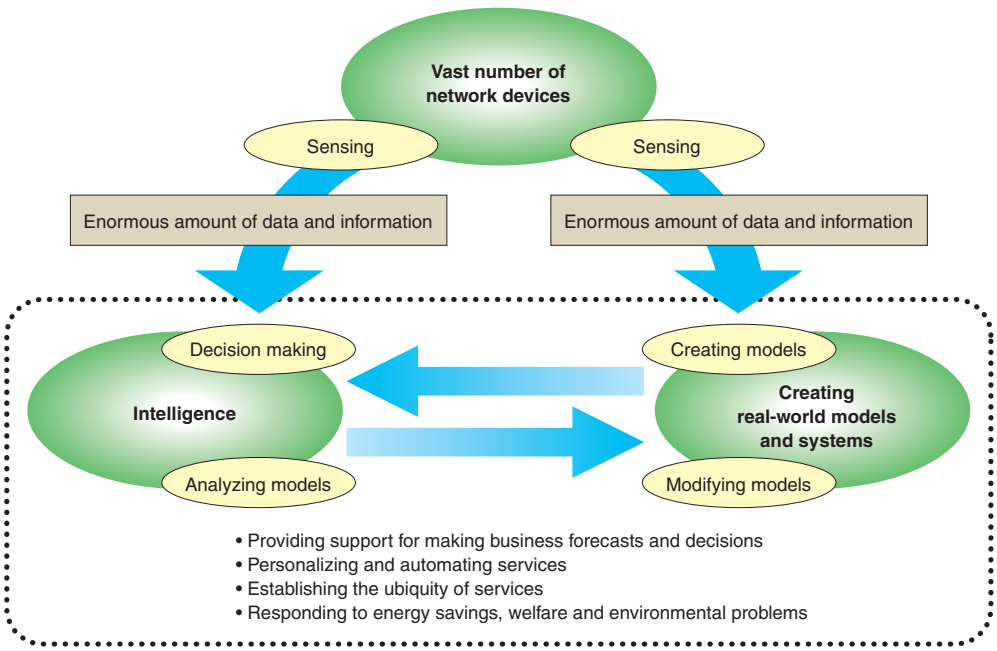
III Features of Information Systems in 2010

Thus far, this paper has taken a general view of the posture of IT in 2010 in the four fields of devices, networks, the development of information systems and information utilization technology. Each field will make technological progress while influencing other fields. Through such evolution, information systems in 2010 will represent a "precise model of the real world" based on information obtained from "a great number of network devices" and will provide carefully tailored services. At the same time, such information systems will achieve "intelligent information processing" such as providing support for human decision making and automating advanced information processing (Figure 5).

1 Network Expansion and "Numerical Augmentation"

The trends toward higher-speed, seamless networks will be further accelerated. Networks will be installed in every corner of society and an infinite number of information and communications devices will be connected to such networks as terminals. While exchanging a massive volume of data, these devices will execute functions on their own on some occasions and execute functions as

Figure 5. Features of Information Systems in 2010



IT Road Map toward 2010

part of a system on other occasions in concert with other terminals and/or high-performance servers.

We will call such expansion of the scale of information systems "numerical augmentation."

2 Realization of "Real-World Models"

The massive amounts of data collected and stored in information systems will gradually come to constitute a model of the real world. What is first required to develop an information system is to express the problems to be dealt with in the forms of certain models. This model will be established by a program and data, and manipulated by a computer.

Because diverse terminals are connected to networks and the number of types of data that are available increases, a model that can more precisely express the posture of the real world will come to be created in an information system. We will call this model a "model of the real world" created in virtual space. It is not that this model will only be used to record occurrences in the real world; it will become possible to use this model to forecast future trends by conducting various simulations, to discover information of value by analyzing data and to derive problem-solving knowledge from this model.

Under its "Digital Human Project," the National Institute of Advanced Industrial Science and Technology is engaged in research on establishing a precise behavioral model based on the massive amounts of data obtained through sensing the daily behavior of humans, and on the methods of utilizing knowledge acquired through establishment of the model.

This project has already created a virtual human being that can exhibit behaviors of children from nine-month-old babies who can crawl to about two-year-old children who can run. The project used an ultrasonic wave location system that can measure behaviors with high precision for sensing the movements of children in units of centimeters. In this project, a system to detect the likeliness of an accident of an infant is also being developed through simulations using a virtual human being.

In the future, ID sensing technology such as RFID and ID management technology called identity management will become important in establishing real-world models. The accelerated use of ID management technology for humans is seen in many corporate information systems and electronic commerce sites for purposes such as authentication and access control.

A wide variety of personal information such as occupation, address, product purchase history, preference, etc. is stored in each information system. While most personal information stored at present is static information that does not change over time, information that will change from time to time will be used in the future as is used under the Digital Human Project, such as location information obtained from sensors. The utilization of such information will enable service providers to offer individuals more carefully customized services.

Similar to ID management technology for humans, the technology for objects will also be used to achieve traceability (recording production and distribution history information) by combining such technology with location information, etc.

3 Emergence of IT with Intelligence

In 2010, it is expected that technology to support decision making and autonomic technology will begin being used through the application of a variety of data such as the operating status of devices and systems on a real-time basis to real-world models established in virtual space. We will call information systems having such functions "IT with intelligence."

The autonomic computing technology employed for the operation and management of servers is one example of IT with intelligence. In the same way that the autonomic nervous system of a living being unconsciously maintains a heartbeat and body temperature, autonomic computing enables systems to manage themselves. One of the objectives of this technology is to automatically respond to any fault based on the troubleshooting information possessed by the system itself.

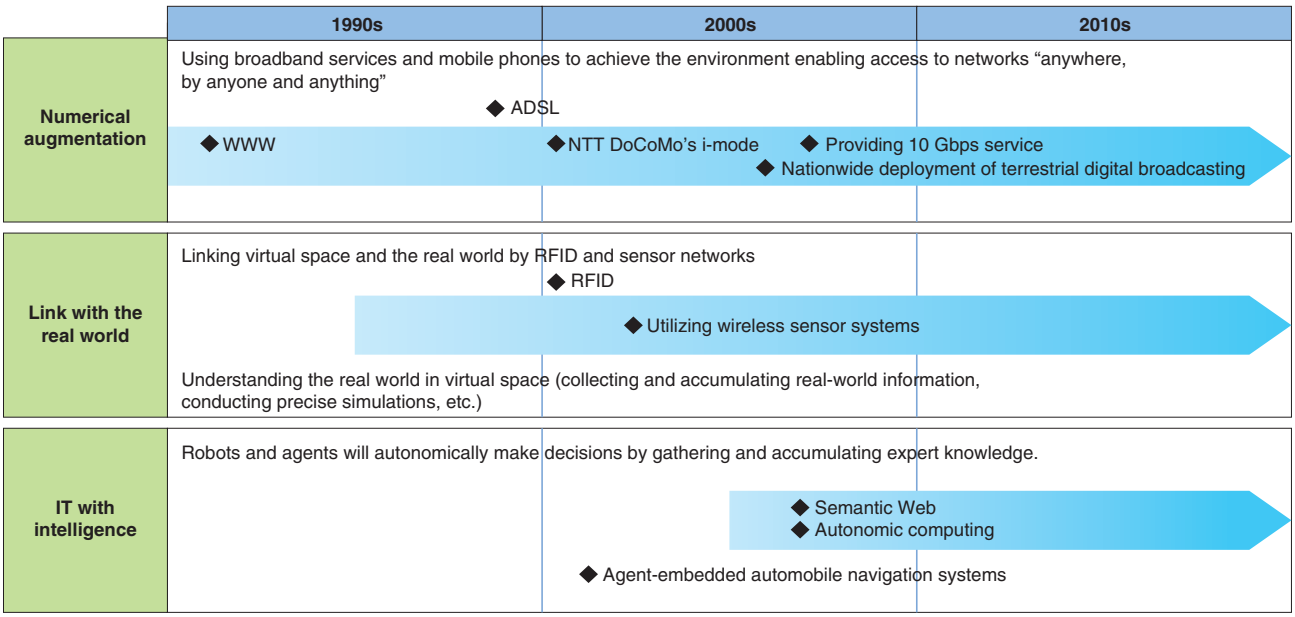
Furthermore, the technology required to detect a specific pattern of transactions on a real-time basis from among massive amounts of transaction data has started to come into practical use. This technology is being used for the detection of fraudulent use of credit cards, failure to comply with the Sarbanes-Oxley (SOX) Act (corporate reform act), etc. Around 2010, "intelligent information processing systems" making use of the expertise of specialists will be used in diverse IT fields.

Figure 6 shows the timing when the information systems introduced in this paper are realized. First, the ubiquitous network environment where it is possible to access networks "at any time, anywhere and by anything" will be established through the evolution of network technology. In the next phase, the massive amounts of data of the real world will be collected from an infinite number of terminals connected to networks, and real-world models will be created in virtual space. After 2010, IT with intelligence will be used extensively and the utilization of vast amounts of information will be promoted.

IV Issues on the Spread of New Technologies

This paper has introduced the IT that will be realized by 2010 from the perspective of technology providers. However, the perspective of users must also be taken into account in order to disseminate these technologies.

Figure 6. New Information System Timetable



Notes: ADSL = asymmetric digital subscriber line, WWW = World Wide Web.

In 2010, a variety of ID management technologies and sensor technologies will become available, and service users will be able to receive personalized services according to their own environment and preference. However, to this end, much more personal information must be disclosed to service providers. The benefits of convenience are inseparable from the issue of privacy.

With the developments of technologies in the future, it will become possible to create precise models of the real world in the virtual world. This will require the development of a technology that enables individuals to easily control the range of disclosure with respect to the personal information stored in the virtual world. As we move toward the era of the ubiquitous network, the spread of technology to achieve such anonymity will become vitally important.

Reference
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Hideaki NAKAMOTO is a general manager of the Information Technology Research Department of NRI and a visiting associate professor at the Graduate School of Information Science, Nagoya University. His specialties include the technology for analysis, design and development of enterprise information systems.
Masatoshi KOMEICHI is a senior IT analyst in the Center for Knowledge Exchange and Creation of NRI. His specialties include enterprise information systems and technology management.

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Inquiries to: Corporate Communications Department
Nomura Research Institute, Ltd.
E-mail: nri-papers@nri.co.jp
FAX: +81-3-5533-3230