NEC's Activities for Developing Business Solutions and Technology Needed for a Ubiquitous Society

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ABSTRACT This paper describes the prospect of a ubiquitous society and the concept of the ubiquitous system on which it is based. Integrating ubiquitous networks and ubiquitous computers, the system, will provide many application services, some of which are introduced in this paper. This paper also explains the basic technologies needed to implement ubiquitous services, such as RFID and its middleware, security technologies, mobile IPv6, and fast IP handover technology.

KEYWORDS **Ubiquitous system, e-Japan strategy, RFID, e-ticketing, IPv6, Fast handover**

1. INTRODUCTION

In Japan, the number of broadband users - FTTH users, ADSL users, and CATV users - is growing at an ever increasing pace. Broadband connections were available in 25% of the nation's households in 2002 and will be available in 70% by 2006. The continuous improvement of the broadband Internet infrastructure is making feasible many kinds of applications using rich-media.

Japanese information technologies have made remarkable progress in broadband, mobile, and home digital appliances and in the fusion of broadcast and Internet areas. Japanese mobile phone usage is the most advanced in the world, and Japanese industry leads in development of digital appliances. We are therefore positioned to play a leading role in developing ubiquitous technologies and various kinds of application service using those technologies.

In June 2004, the IT strategic headquarters of the Japanese government adopted the e-Japan strategy II acceleration package in order to accelerate the e-Japan strategy program (**Fig. 1**) that started in June 2003. Its goal is to turn Japan into the most advanced IT nation in the world by 2005.

It focuses on seven fields: healthcare, food, life, financing for medium-size and small companies, knowledge, work, and administrative services. The use of IT in these seven fields will result in a ubiquitous society.

To achieve this goal, we have to develop not only the infrastructure, but application services to utilize the strongest infrastructure as well.

This paper first describes the prospect of a ubiquitous society and then describes several key applications along with their system platforms and novel technologies adding new values.

2. PROSPECT OF OUR UBIQUITOUS SYSTEM

2.1 Concept of Ubiquitous System

There are the two trends toward the ubiquitous society. One is the trend for the ubiquitous networks and the other is the trend for ubiquitous computers.

On the one hand, many heterogeneous network systems will be seamlessly integrated into ubiquitous networks giving us access to every piece of information we need. There, the user will not designate a specific network system, but he can utilize any kind of access network shown in the left-hand circle of **Fig. 2**.

On the other hand, various kinds of computers will be connected to one another via network. Users will access information services using the many types of terminal devices shown in the right-hand circle of Fig. 2. The point to notice is that new devices - smart IC cards, RFIDs, and sensors - will be connected to the networks and will play important roles. Smart IC cards, used with other terminal devices, will communicate personal information safely and securely. RFIDs and sensors will play remarkable roles in the ubiquitous society; they will link our real-world activities to information services.

We define a ubiquitous system as a system that integrates ubiquitous networks and ubiquitous computers to obtain information about real business

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scenes all over the world at this moment and to use this information in real time to promote our customers' business growth.

2.2 Ubiquitous System Components and Evolution

The ubiquitous system based on the concept described in subsection 2.1 consists of the three functions shown in **Fig. 3**. In each function, the technology level will extend from the physical level to the semantic level.

The first function is unveiling. This function finds information buried in the real world. So far, even if significant changes occur in business scenes, we find them only after they affect business results. It is often too late to cope with the changes. By using this unveiling function we will be able to immediately comprehend significant changes and adjust business activities accordingly.

The second function is unification. Heterogeneous networks will be seamlessly integrated at the

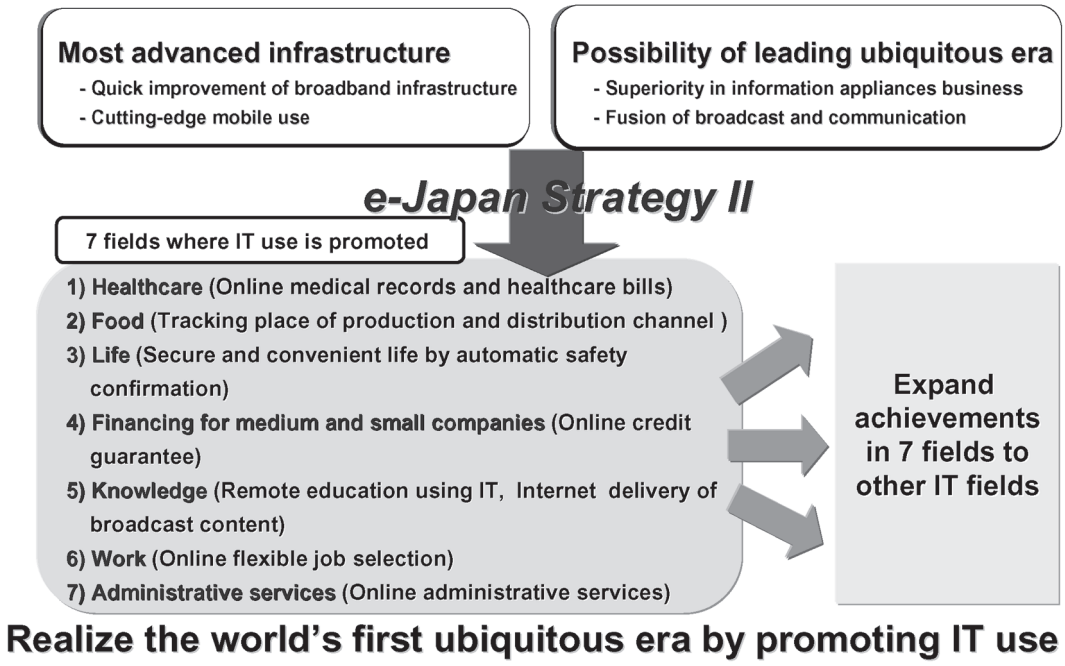

Fig. 1 e-Japan strategy II framework.

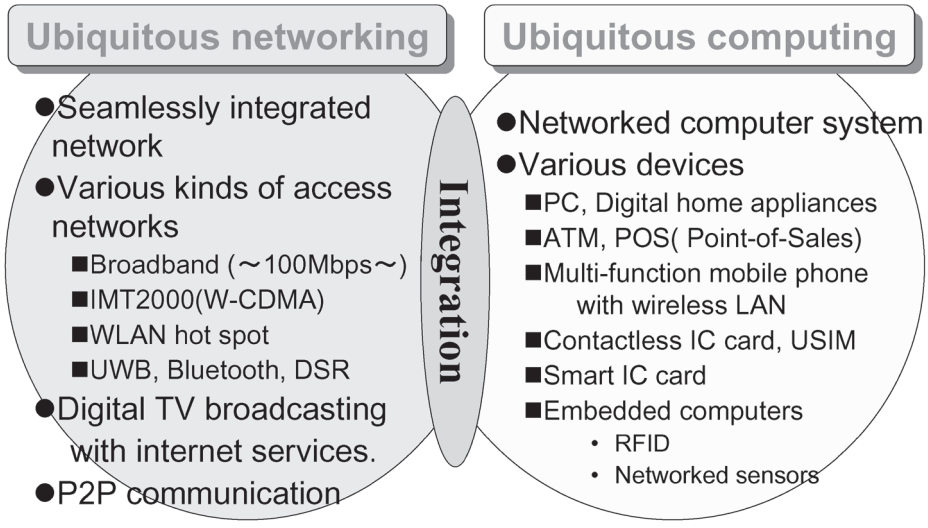

Fig. 2 Concept of ubiquitous system.

physical level. At the logical level, information systems will be integrated to serve mobility and continuity. Grid computing based on these integrated networks and systems will be also implemented. At the semantic level, communication between people will evolve to communicate their intentions.

The third function of the ubiquitous system is utilization. The ubiquitous system unifies pieces of information that are unveiled in many places in order to comprehend what occurs in real business scenes at this moment. It then uses this unified information to control business for success as soon as possible. At the semantic level of this function, the system will help its users create new businesses and find latent markets. We will create ubiquitous application services by combining technologies out of the three functions according to both the evolution of the technology and the growth of our society.

3. UBIQUITOUS SOLUTIONS

3.1 Ubiquitous Services

This section introduces ubiquitous application services produced by the component functions described in the previous section. **Figure 4** shows the projected time frame of promising ubiquitous services and their expecting market volumes. In the first stage of the ubiquitous era, secure and safe e-commerce applications and monitoring/control applications will lead the market. SCM and asset management using RFID have already become feasible in the enterprise application area. Location information service is currently in a feasibility study phase, and its expected market size is about 100 billion yen.

Various ubiquitous devices will be available in the second stage of the ubiquitous era, content adaptation and personal agents services which will be implemented using those devices will follow the 1st stage services.

In the third stage, sensors and microchips will be embedded everywhere providing a truly ubiquitous environment. The Intelligent Transport System, which is a stereographic example of ubiquitous applications, will become widely available around 2005 and its market size is estimated to be about 1 trillion yen. Context-aware information services will also be available in the third stage.

3.2 Brand New Services and Their Platforms

Figure 5 shows a variety of ubiquitous solutions using NEC's technology competence. NEC has a great deal of system integration experience gained while developing service platforms based on technologies such as mission critical system, scalability, security, real-time processing, and authentication. Therefore, we have a lot of potentials to realize various ubiquitous services.

We are currently focusing on five areas of services (see Fig. 5) depending on the requirements and growth of the market. They are electronic ticketing services, RFID-based services, public services using ubiquitous access, home security/control services, and location-information services.

An electronic ticketing service using mobile phones looks promising because the prevalence of mobile phones is extremely high in Japan and the functions of mobile phones is still becoming richer. Some potential uses of mobile phones are as membership cards, entrance tickets for movies and sports events, and transportation passes.

RFIDs will also play a key role in ubiquitous systems because they make it possible for property man-

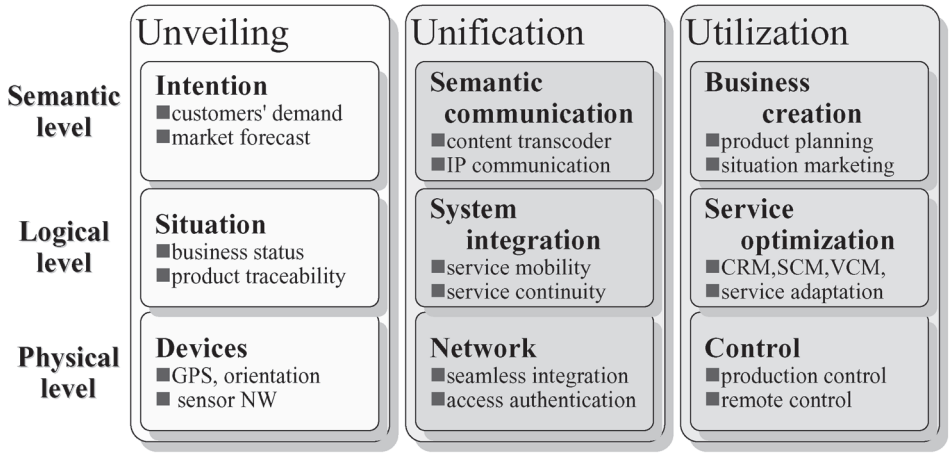

Fig. 3 Functions of the ubiquitous system.

agers and production managers to trace the location of properties and situation of production lines.

Three other services are based on the ubiquitous functions that enable everyone see, access, and control information or appliances from anywhere at anytime.

3.3 Examples of Ubiquitous Services

(1) Electronic Ticket Service: Light Holder

We have studied the feasibility of an electronic ticketing system for rugby football games (see **Fig. 6**).

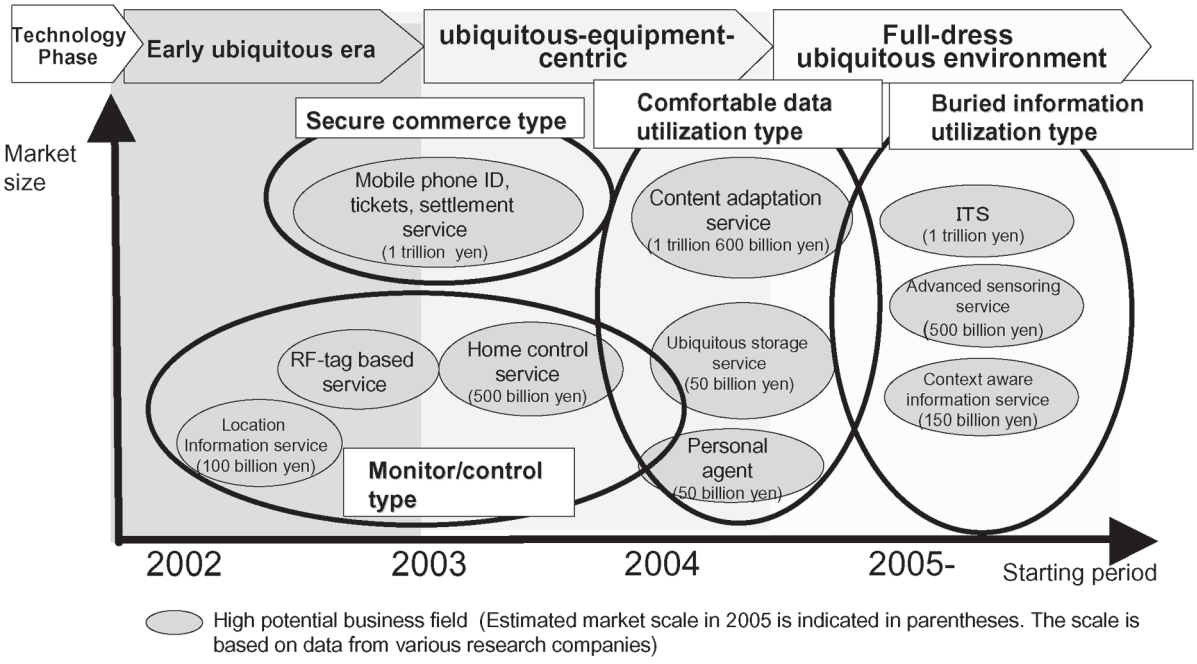

Fig. 4 Size of market for ubiquitous services.

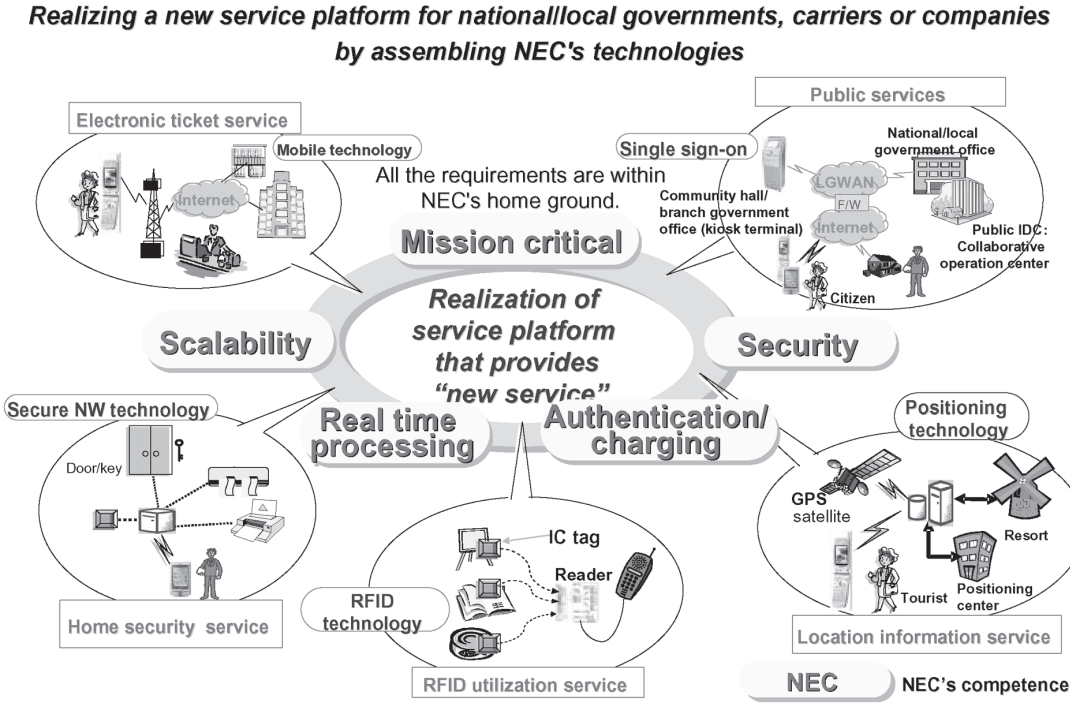

Fig. 5 Ubiquitous solutions.

About 500 people per game joined the case studies, which proceeded as follows:

- A member of an NEC sports-supporting group first applies to a drawing for the game tickets.
- After getting the notice of drawing, the member downloads a ticket to his mobile phone in advance.
- He goes to the football stadium and gets his downloaded ticket authenticated by communicating with a personal computer through infrared technology.

The implementation of this experimental service was based on "LightHolder," NEC's mobile e-ticket & membership-card service platform software that provides the service plug & play function for the processing flow described above. It also lets operators and members use the system by execution simple operations on Web browsers.

(2) RFID Utilization Services

Figure 7 shows an example of a fresh food traceability support system. With wireless tags, fresh food can be traced from the place of production to the storefront or to the consumer's home. The system enables producers, distributors, retailers, and

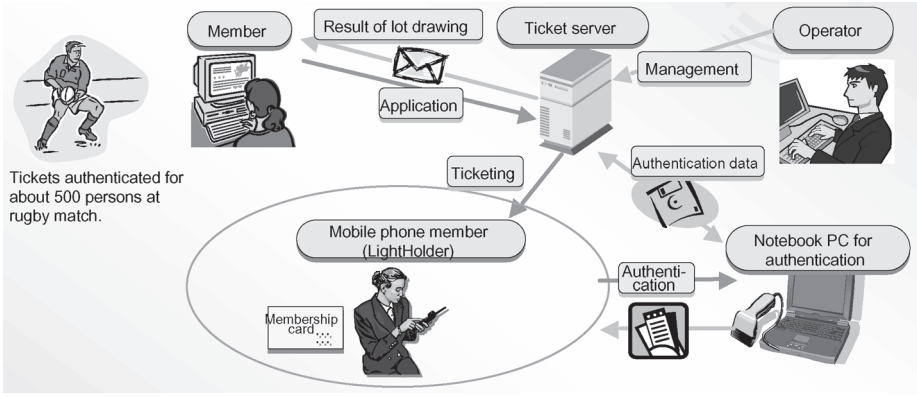

Fig. 6 Configuration of E-ticketing system used by NEC sports-supporting groups.

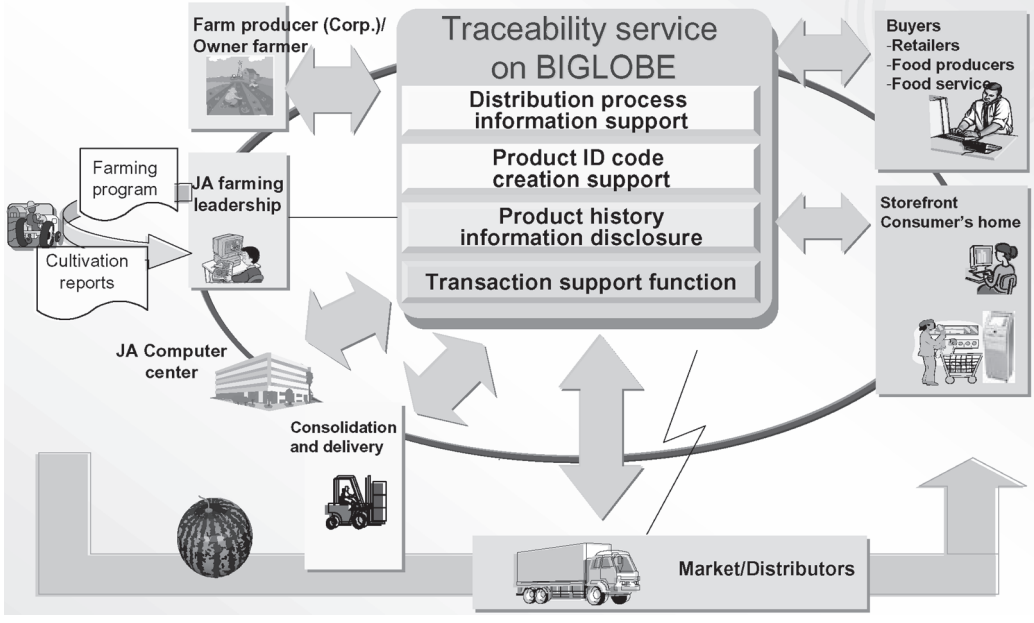

Fig. 7 Traceability service solution using RFIDs.

consumers to share information about produce on a daily basis. The system helps farm producers to enter production information, prepare production plans, and collect bills.

At the JA (Japan Agriculture) center, RFIDs are attached to all goods and all goods can thereafter be traced.

4. TECHNOLOGIES FOR UBIQUITOUS SYSTEM

4.1 Basic Technologies

Ubiquitous systems require wide varieties of fundamental technology ranging from the device level to the application level. We have selected seven basic technology areas which will play dominant roles in creating ubiquitous services (see **Fig. 8**). At the device and component levels, ubiquitous sensors and microchips, mobile/wearable terminals, and RFID devices are the key components making new services possible. At the platform level, grid computing and security are key technologies for the ubiquitous environment.

Utility computing is an ultimate ubiquitous computing environment. People can use computing/network/storage resources including applications without having their own facilities. Authentication and privacy protection become more and more important in such an environment. At the network level, seamless IP handover between heterogeneous networks is essential for users to access the IT environment seamlessly. These technologies are explained in detail in the following subsections.

4.2 RFID

The RFID (Radio Frequency Identification) system is an automatic authentication system that reads information stored in IC chip using radio wave. RFID technology was originally developed by U.S. Forces in 1940.

RFIDs or IC tags have recently become one of the basic technologies used in ubiquitous systems. As shown in **Fig. 9**, information stored in a RFID can be read by a reader device and processed in a PC/PDA to become higher-level information. It is also possible to write information to an RFID. Both the read and write operations can be accomplished by wireless communication.

RFID middleware is also a basic component of RFID solutions (see **Fig. 10**). It is used to process information read from an RFID, link its tag-ID and other information, and manage the information.

The RFID server platform reads out device information and connects it to related information. The context-extraction platform processes device-related information from the RFID server platform into data necessary for applications. At this point, detecting a lack of information and/or data discrepancy is

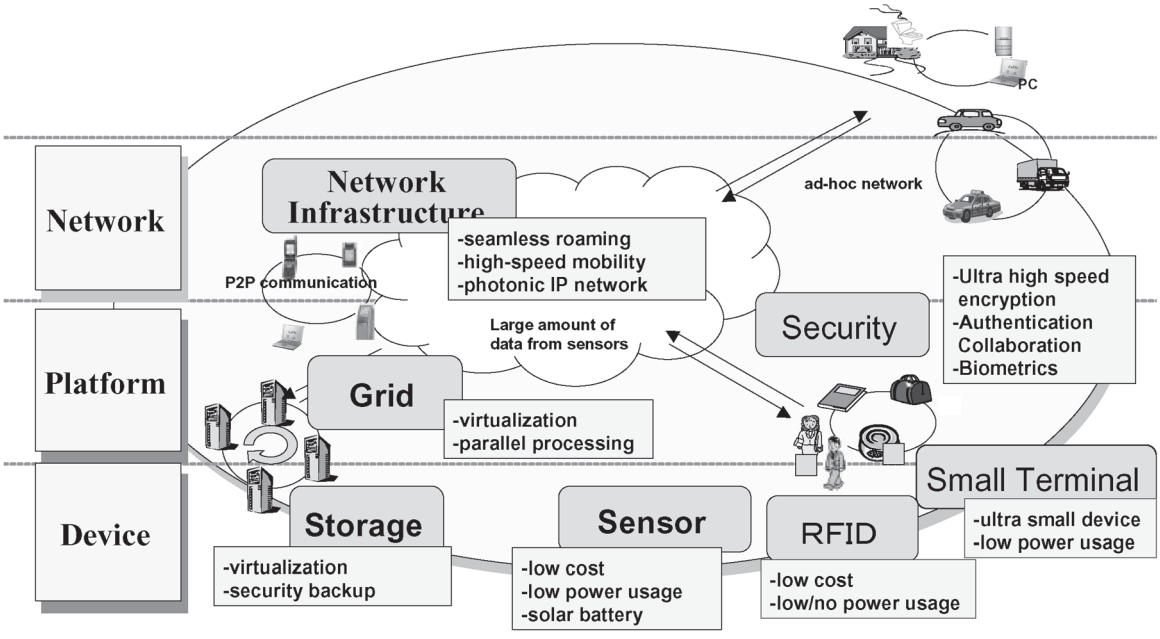

Fig. 8 Basic technologies for the ubiquitous system.

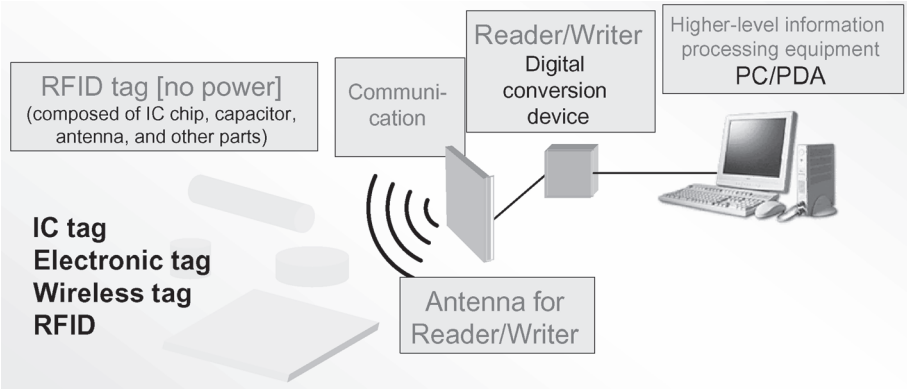

Fig. 9 Standard configuration of widely-used electromagnetic induction type.

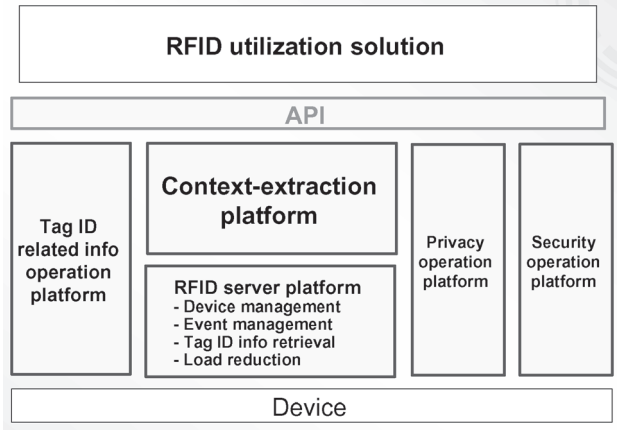

Fig. 10 Architecture of RFID middleware.

important because ID recognition by tag-readers cannot be 100% correct. The RFID server platform and the context-extraction platform work collaboratively to find/modify device nondetection or misdetection and data inconsistency among multiple devices.

The privacy-operation platform prevents other persons from scanning an ID and collecting information without the user's consent.

4.3 Security Technologies

In a ubiquitous society, we can enjoy sophisticated services by using our personal information, such as where we are and what we prefer. If users are going to access the IT environment from anywhere and get seamless IP services, the firewall boundary should be dynamically changed according to the user's location and authority. Security is therefore very important for protecting private information. Comprehensive security should be implemented by integrating IT and NW technology (see **Fig. 11**).

The following functions are needed for providing secure services to "anyone, anytime and anywhere."

· Integration of authentication functions (login function)

It is important to develop an authentication federation system providing a single-sign-on environment for enterprise backyard systems and web applications.

· Protection of private information

Preventing information leaks has recently become extremely important. We are therefore focusing on preventing secret or private information from being released by mistake or on purpose.

· Reinforcement of countermeasures against cyber terrorism

Collaboration of the FW (ExpressSG300) and the web-falsification-detection system makes it possible to detect unknown attacks.

4.4 Mobile IPv6 and Seamless IP Communication

NEC provides multimodal access across fixed or mobile networks using Mobile IPv6 (**Fig. 12**). The Home Agent in IP access networks holds an IPv6 address assigned to a user visiting a remote area.

NEC has also developed fast IP handover technology that provides seamless IP communication, over an 802.11b Wireless LAN, from a car or train moving at a high speed (**Fig. 13**).

The effectiveness of our "fast IP handover" technology has been demonstrated experimentally for rapidly moving bodies (333km/h).

Fast IP Handover is NEC's unique technology to

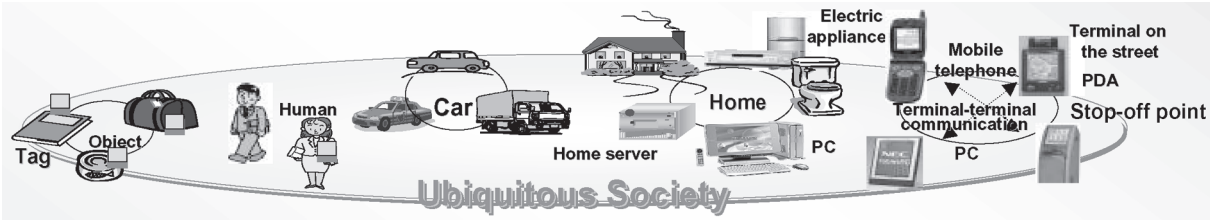

Fig. 11 Security for ubiquitous systems.

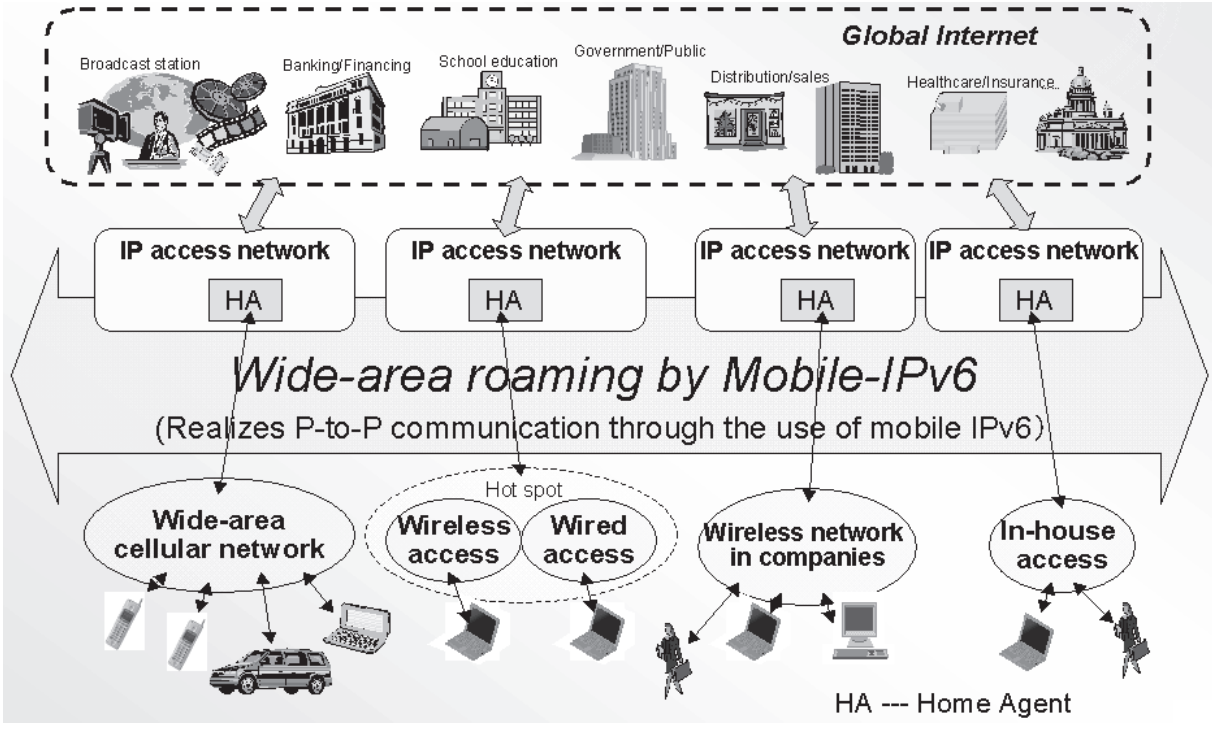

Fig. 12 Mobile IPv6.

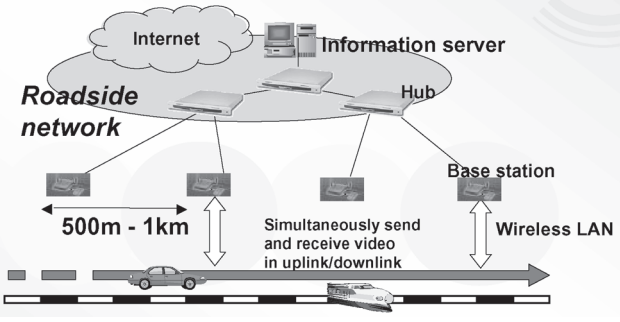

Fig. 13 Network infrastructure for high-speed mobility.

implement fast handover at IP level by exchanging the location-registration information of moving bodies among hierarchical routers.

5. CONCLUSION

This paper describes the prospect of a ubiquitous society, the concept of a ubiquitous system, examples of ubiquitous services, and basic technologies needed for the ubiquitous society.

We are currently in the beginning of the ubiquitous-equipment-centric stage in which many application services will be tried. We defined ubiquitous technologies as the combinations of unveiling, unification, and utilization. We will move from the physical level to the logical level and semantic level in

order to provide a full-fledged ubiquitous environment and the world's most advance ubiquitous society.

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