Platform for Realizing Ubiquitous Services

Masahiro Kawahara

Downsizing and standardizing were the trends in the IT industry during the first half of the 1990s. As a result, the main platform of information system shifted from a mainframe to UNIX®*1) or Windows®*2). The TCP/IP equipped with on these platforms established a position as standard communication protocol of information system. The wave of standardization was not limited to communication protocols, but rather, numerous technologies used by information systems at the time became standardized. Furthermore, convenience of a user improved because various information services cooperated through a network. The standardization of communication protocol by TCP/IP supported the spread of Internet strongly.

On the other hand, SIP (Session Initiation Protocol) released in 1999 brought a big change in an information and communication system. SIP made it possible to connect information system and a communication system. By SIP, fusion of an information service and communication service began on IP network. As a result, the new service that integrated data with a sound was created. This marked the beginning of the fusion of an information service and communication service. At OKI, technology developments were carried forward based on the information and communication convergence solution concept, referred to as the "AP@PLAT®"*3). Through such efforts, various information and communication convergence applications were built and environments for running such applications were offered, with the SIP&Web convergence application server at the core[1].

Trial services for the Next Generation Network (NGN) begun in Japan in 2007, accelerating the completion of a network infrastructure to fully convert communication systems to IP. The full conversion of communication systems to IP with the convergence of information and communication, which OKI has been promoting, is approaching the final stage of realization. Furthermore, the move from the convergence of information and communication towards the fulfillment of an infrastructure to achieve the ubiquitous society, is also starting to pick up speed in the information and communication industry. AP@PLAT is also starting to evolve from an information and communication convergence application to an entity that builds ubiquitous services and provides an environment for such services. It is no longer merely a convergence of voice services with data services, but rather it aims to realize an information infrastructure that makes available the use of "desirable services in desired modes" in a "safe and reliable" manner "at any time, anywhere and with any entity".

Incidentally, the ubiquitous society we are considering is a society wherein everyone can live a social life that is more plentiful and safer with information and communication systems providing support for the activities of people. To make available very convenient services, anywhere and for everyone, with peace of mind at all times, is the aim for the ubiquitous society. The original meaning of "ubiquitous" was to create computers that are pervasive in the living space of people. What people are aware of in the ubiquitous society are services and, therefore, it will be services that are pervasive in the living space. Such services are defined as ubiquitous services. The prospective features required of information and communication systems to achieve such ubiquitous services are herein presented with an introduction to the ubiquitous service infrastructure under consideration by OKI.

Changing demand for services to perspective of users

Information and communication systems are essential entities for us at the present time, both in terms of social infrastructure and also as an infrastructure for supporting corporate activities. Although information and communication systems have been offering beneficial services, they have also been subjecting users to a lot of restrictions. For example, a scheme of telephone numbers implemented for telephone systems was necessary to resolve the confusion of telephone numbers before communications could be established with other parties, therefore, a telephone numbering scheme was implemented to resolve the problem of connecting people. However, the operation of locating a telephone number in a telephone book and then dialing that number (initiating a call) is undoubtedly a restriction that the telephone system imposes on its users. The IP telephone system, which has become more popular in recent years, offers a selection of modes for communicating that are more suitable for the particular conditions of the other party. It is also possible for users to communicate with other parties without the users being aware of any

*1) UNIX is a registered trademark licensed in the United States and other countries by X/Open Company Ltd.
*2) Windows is a registered trademark of Microsoft Corporation in the United States and other countries.
*3) AP@PLAT is a registered trademark of Oki Electric Industry Co., Ltd.

telephone numbers.

Many restrictions are imposed by financial systems. In order to withdraw cash funds from an account, for example, a passbook and a personal seal (or signature) must be given to a bank teller, whereas a cash card and a personal identification number (PIN) must be used in automated teller machines (ATMs). In both cases these requirements involve physical mediums used to identify the user as the owner of the account. Without such mediums it is not possible to withdraw any cash funds, even if the user is actually the owner of the account. Financial systems subject the users to restrictions through such requirements. The development of biometric authentication technologies have advanced in recent years and it may become possible in the near future to withdraw cash funds without the need for physical mediums. Once that becomes a reality restrictions for receiving financial services will be eliminated, thereby improving convenience for users. Furthermore, electronic money, which rapidly gained in popularity recently, is part of a system capable of transferring user assets as digital data. If we were to consider cash funds as a physical medium for transferring assets, then electronic money could be considered a system for raising the level of convenience by eliminating physical mediums.

Attempts to digitize physical mediums are being undertaken in a variety of industries, not only financial systems. Convenience has been improved for the use of modes of transport, such as railways and airlines, which required tickets, however, through the conversion of physical mediums into digital data tickets are no longer required.

In a broadcast system, it is necessary for users to adhere to the broadcasting schedules in order for particular content to be viewed. And a user has to adapt itself to circumstances of a broadcast system to record contents. An on capable of distributing the required content according to the demands of users. This is an example for eliminating the restrictions imposed on the users by the broadcasting systems.

As described thus far, conventional information and communication systems have subjected users to numerous restrictions. The need to operate dedicated terminals to obtain information, the availability of dedicated terminals only at particular locations and between certain times, the need to enter personal information or information relating to the status of the time, every time a service is used, or the limitation of means to enter information to a particular input device, such as keyboards, are all examples of imposed restrictions. In other words users were able to use the services by accepting the restrictions imposed by the service providers. Recent advancements in information and communication technologies, however, have made it possible to eliminate, little by little, the restrictions that users have been subjected to in the past, thereby improving convenience for users. This shifted the tendency of users to demand services that are more focused on core values. The capability to connect one telephone call to another party simply by announcing the name of the party, to listen to content at any desirable

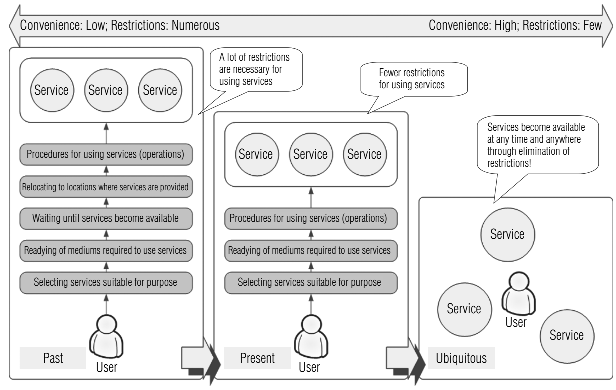


Fig. 1 Changing relationship between user and services

time and to board an airline without purchasing a ticket, described earlier, are examples of such features. Elimination of the restrictions imposed by service providers is a requirement that users demand of ubiquitous services (**Fig. 1**).

Changing demand for corporate information systems

The demand for corporate information systems is also changing. Many corporations own multiple information systems that are operated internally. Except for some leading-edge companies, there are no link ups between individual information systems and the users themselves are performing the business operations by linking these systems manually. Searching for products in an inventory control system and entering the information about such products into an order processing system is an example of such a case. If the inventory control system and order processing system were linked up, the workload and man-hours of the user, as well as operating errors would all be reduced.

The architecture of corporate information systems has been evolving from a centralized and vertical architecture with a mainframe system, to a client-server system with adopted open technologies, as well as a multilevel-type with web technologies and lately the Service Oriented Architecture (SOA) that connects multiple individual systems through a Simple Object Access Protocol (SOAP), which is a standard for exchanging XML based messages over a network. In other words the era wherein individual corporate information systems were built using dedicated technologies and were optimized individually, changed to an era where standardized technologies were used to link up multiple corporate information systems and at the present time a system architecture for optimizing information systems of the entire corporation is becoming the mainstream. Information systems that were isolated and on their own in the past have been connected and linked up to enable smooth distribution of information between information systems while improving user convenience.

Paradigm shifts required of information and communication systems

By considering the information relating to changes in demand for services from the perspective of users, as well as changes in demand for corporate information systems as the demand that drives the changes, we will be able to see the four paradigm shifts (changes in demand for systems) that will shape the changes of information and communication systems in the future.

The first such paradigm shift relates to changes in the generation of information, as well as methods used to collect information. Easier collection of information brought about through the advancement of information and communication technologies create such major changes. In the majority of cases in the past information was generated once it had been entered by users. Information, however, can be generated when operations are performed for example, when the locations are entered on a mobile phone while moving to obtain location based services or when the travel routes or transportation expenses are entered on a personal computer for the settlement of business trip expenditures or when a PIN is entered at an ATM to withdraw cash funds. Recent information and communication technologies have reached a point where they are almost able to abbreviate some of the data entry operations. Information on the routes or transportation expenses obtained from transport timetable search services, for example, may become capable of automatically entering the travel expense related information into the expenditure settlement system or the Global Positioning System (GPS) feature incorporated in a mobile phone could be used to automatically obtain information on the location or personal identification that involves the use of a PIN, which may no longer be necessary when biometric technology is used. Furthermore, by completing the wireless infrastructure, along with the advancement of sensor networks and sensing technologies, as well as by using video monitoring technologies, detailed and accurate information can be automatically generated and collected, thereby reducing the instances that require users to perform data entry operations themselves. Even when users initiate the entry of information it will not be limited to a particular user interface, such as keyboards, as it will also be possible to enter information with voice entries, gesture entries and a diverse range of operations and interactions with systems (information entry of systems).

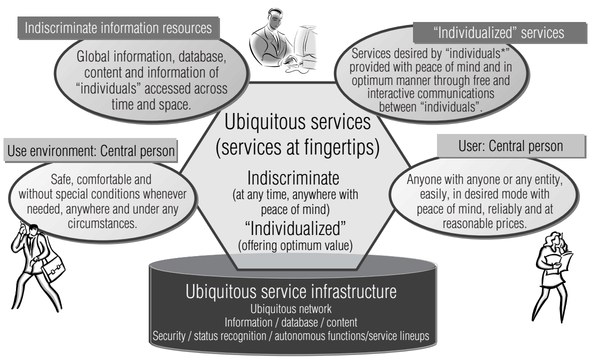
Changes relating to the methods of transmission are the second such paradigm shift. Information is transmitted to an information system via a network by an object such as a person or a thing the edge of that network. Alternatively, the transmission of information will increase from an information system to another information system, as well as the flow of feedback on the results of information processing from an information system to an object, along with the peer-to-peer-type (P2P) transmission of information from one person to another person or from one thing to another thing, such as with IP phones. With the automation and acceleration of information entries, more detailed information will be generated at the edges of networks and the amount of information will multiply. Furthermore, with the expansion of networks through the inclusion of sensor networks, home networks and vehicle-mounted networks, devices (such as various sensor devices and information appliances) will grow in number as well, resulting in a huge amount of information being fed by a large number of objects that exist at the edge of networks and an enormous amount of information will flow across the networks. Attempts to broaden convenience for users by providing composite services comprised of related but individual services are increasing in number also. This trend will add to the amount of information transmitted among services. As described thus far, the capability to transmit large amounts of information across routes more complex than ever before will be required. The contextual information of individuals will also be included in such information and, therefore, security during the transmission of information will also be necessary.

The third such paradigm shift relates to the changes for storing and searching information. The increased number of objects at the edges of networks will simply result in an increased amount of information. Data stores for managing such information in an efficient manner will be required and at the same time the needs for exchanging such information between services (between systems) will also increase. This means that large scale data stores, which manage large amounts of information, must exist, dispersed throughout the networks. Furthermore, various data stores will be connected via networks, such as existing services and data stores, as well as data stores on terminals that maintain the information of objects existing at the edges of the networks. Mechanisms will be required for flexibly managing and searching for such data stores of various sizes that are ubiquitous throughout the network. Furthermore, not only will it be necessary to manage large amounts of information, but it will also be necessary to create mechanisms for extracting the meanings of what the users desire from such information.

The changes relating to the use of information are the fourth and final such paradigm shift. Users not only want to be free of restrictions that require them to be at a particular location or to use a specific terminal, but from the perspective of users a demand exists for a means to use services via user interfaces, allowing them to use any preferred terminal out of various terminals ranging from information appliances to mobile terminals, whether they are at home or on the move outside. Looking at corporate information systems, on the other hand, there is demand not only for the individual use of information systems, but rather, highly convenient environments made possible through a link up of relevant systems (service linkups). Other needs must also exist, such as the availability of access to corporate information systems both inside and outside the corporate environment.

Shared features of ubiquitous services

We believe that responding to the changing demand of services from the perspective of users and changing demands relating to corporate information systems, which have been described thus far, will ultimately enable us to offer ubiquitous services. The shared features that must be equipped in the ubiquitous services as well as the information and communication system infrastructure (ubiquitous service infrastructure) supporting ubiquitous services are summarized in **Fig. 2**.



* Individuals are persons, things, living organisms, locations, environments, corporations, societies, countries, etc.

Fig. 2 Ubiquitous services and their infrastructure

The following features will be required for a ubiquitous service infrastructure:

(1) An advanced information collecting attribute keeps track of the status of objects (for autonomously tracking the status of occurring situations in real-time, using sensing technologies and recognition technologies).
(2) A network infrastructure for transmitting collected information in a secure and reliable manner, as well as in real-time (security feature that connects objects existing at the edges of networks with systems, as well as systems with systems in a flexible yet secure manner).
(3) A feature for efficiently managing large capacity data stores and dispersed data stores, a data mining feature for effectively using information stored in such data stores and a feature for searching for particular information from among the data stores that are ubiquitous over the networks.
(4) A service linkup feature autonomously detects the required services, connecting to such services and exchanging information with such services.
(5) Multi-modal and multi-device features provide flexible data entry methods to accommodate conditions of the users, making the most suitable terminal available for use.

The aforementioned attributes are not only vital for realizing ubiquitous services. Changes in the requirements of users represent expansion and a segmentation of the networks, as well as increases in the amount of information. In other words, it will be necessary to delve into regions that could not be reached by networks in the past and to capture in real time phenomena taking place in the real world. The number of objects employed to transmit and receive information will multiply in order to capture phenomena in the real world. Furthermore, if large amounts of information are acquired, which could not be obtained in the past, the amount of information distributed to systems will also expand. Therefore, network systems capable of processing large amounts of information generated by a large number of objects are imperative.

Handling the information (primary information) generated in large amounts simply in the form of primary information places too much of a burden on the calculating process. A process to filter the primary information in the information distribution process and convert it into contextual information that is meaningful to users is essential. Incorporation of such a context conversion process to disperse over the networks is vital.

Networks transmitting large amounts of traffic need a transmission capability that accommodates the amount of information generated and routing taken by information, as well as characteristics of the information (tolerated delays and throughput). In other words, an attribute is required to dynamically control network bandwidths and delays. We consider NGN to be an infrastructure capable of realizing such requirements.

Furthermore, since information relating to persons (users) is included in information handled by such systems, the need to provide encryption and authentication for protecting the information, as well as security technologies for assuring the security of transmission routes, goes without saying.

Furthermore, session establishing technologies for connecting the objects such as persons or things with services, objects with objects, as well as services with services will be essential, along with session management (context management) attributes for retaining the status of objects.

Activities undertaken by OKI

OKI is promoting the creation of an infrastructure for realizing ubiquitous services, with the vision of an "e-Society®"*4). The "e-Society" being considered by OKI is comprised of a ubiquitous network (a ubiquitous network

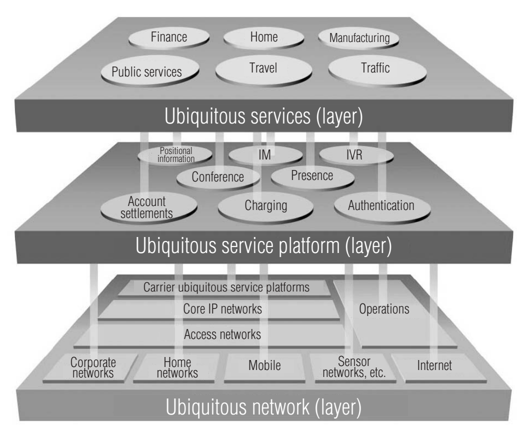


Fig. 3 Architecture for realizing e-Society

*4) "e-Society" is a registered trademark of Oki Electric Industry Co., Ltd.

integrates and controls different types of networks and a ubiquitous service platform provides infrastructural functions for services), which enables access at any time, anywhere and with any entity, as well as ubiquitous services that are the principal components providing optimized services to the status of objects[2]), as shown in **Fig. 3**.

The ubiquitous service (layer) is a layer on which services of various lines of business are provided. These services range from those that provide single functions to those offering composite services comprised of a combination of multiple services. New value added services are provided to users by connecting such services in a flexible manner.

The ubiquitous platform (layer) at a lower level makes it possible to easily incorporate services by virtualizing physical structures of a diverse range of networks and data, as well as various devices. Furthermore, the ubiquitous service platform not only virtualizes physical structures, but it also provides functions, such as authentication, charging, name service, directory service, data storage and session management.

The ubiquitous network (layer) provides features to seamlessly connect fixed and mobile telecommunication carrier networks, as well as corporate networks, home networks and sensor networks. Furthermore, traffic control and network device control, as well as network security, are also provided by this infrastructure for securing and reliably transmitting information. OKI is undertaking activities to realize NGN in the belief that this will become the core of the ubiquitous network.

Ubiquitous service infrastructure

A summary of the infrastructure for the realization of ubiquitous services is shown in **Fig. 4**. Ubiquitous client platforms on terminals and ubiquitous service platforms on servers with the ubiquitous network at the core comprise the infrastructure. This platform for realizing ubiquitous services, depicted in the figure provided, shows the structure on functional levels (**Fig. 5**).

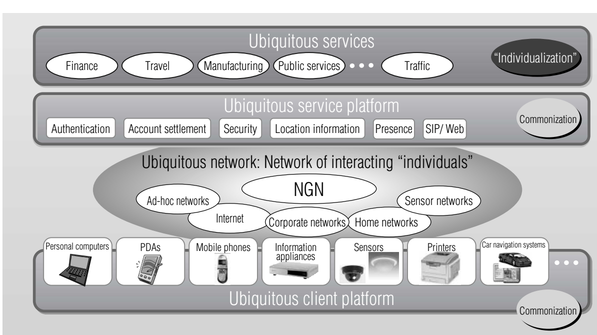


Fig. 4 Platform for realizing ubiquitous services

Currently the popular Internet (2 locations) is a system intended for the distribution of large amounts of information (content) for an unspecified number of users. Furthermore, the current mainstream corporate information systems are intranet systems adopting web

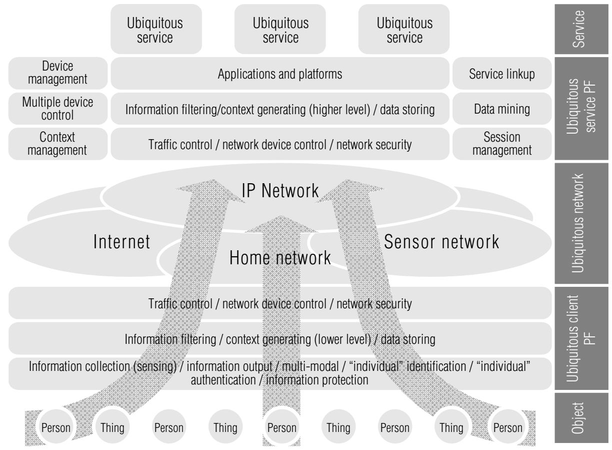


Fig. 5 Structure of ubiquitous service infrastructure

technologies that are the same as those used in the Internet (2 locations). The overwhelming amount of information flowing through these systems takes the downstream traffic pattern from the server to the clients. Only a relatively small amount of information flows upstream in traffic from the clients to the servers. As mentioned earlier, however, ubiquitous services utilize ubiquitous networks that span all corners of the world with sensing technologies to autonomously collect information from a large number of objects. For this reason, large amounts of upstream traffic, generated at the edges of networks and sent to servers, are anticipated. It is not possible to efficiently process such upstream traffic with architectures that use the currently available web technologies.

Fig. 5 is a diagram depicting an image of the upstream traffic in particular. Objects (objects, including persons and things, are expressed as "individuals" at OKI) are at the edges of networks. Functions to identify and authenticate objects, collect information from objects, output information to objects and protect information collected from objects, are allocated on the layer closest to the objects. A function provides a selection of multiple options for operations, such as key operations, voice commands or gestures to suit the conditions of objects or preferences of users, with regards to input and output of information to and from objects. At the present time voice recognition technologies have reached a level where practical implementation is feasible. We are hoping to resolve the issue of digital divide by readying multi-modal functions.

Functions for filtering the collected information and generating context from primary information will be allocated on the second layer, as seen from objects. Furthermore, in order to generate meaningful context from primary information, relative information, such as chronological information or location information, will be required. For this reason data stores of a small scale will be installed at those locations as well. A reduction in the load for the system as a whole is the intended objective of such efforts, since it will be possible to reduce the amount of information that flows across networks.

Furthermore, whenever decision making is possible on such layers we intend to make it possible for these layers to issue feedback to objects without notifying the relevant servers.

Primary information generated by the objects are processed through context conversion and provided to servers via networks. Network control functions assure throughput or delay, as well as security levels according to the features of the context information (such as real-time characteristics, reliability, security level, etc.) transmitted at this segment where a connection is made to networks.

Context information generated at the edges of networks arrives at servers after traveling through various networks. The ubiquitous network (layer) integrates a diverse range of networks with features that provide seamless access to keep ubiquitous services at higher levels and unaware of the differences between networks.

Context information transmitted to servers is processed through more advanced context conversion processes as needed and sent to ubiquitous services to which this information is bound. Context conversion functions available at this layer generate advanced context based on information relating to a wide range of objects that cannot be recognized at the edges, as well as information collected from different networks and even information that had been stored for long periods of time. Data mining functions for extracting the beneficial meanings from large amounts of information are also allocated there as well.

A session management feature for connecting "any time, anywhere and with any entity" is necessary for servers and we believe that the SIP technology can become the core of such features. In practice, numerous SIP servers that exist across networks will be linked up with each other to manage connections among objects, as well as objects with services. Furthermore, the service linkup maintains service repositories for binding objects with services, as well as linkups between services. Individual services will be registered with such repositories and the required services will be extracted from the repositories binding them dynamically.

Device management maintains information relating to the specifications and status of the terminals (devices). Furthermore, multiple device control is an engine for generating output that is optimized for the specifications (such as a user interface, etc.) of terminals. These functions will enable ubiquitous services to maintain the proper monitoring of the terminal status to enable them to provide output that is most suitable for the objects (terminals).

Context management is allocated to servers in order to ensure that ubiquitous services are available, "at any time, anywhere and irrespective of the devices used" by objects. Although currently available thin client systems and Web 2.0 services do already manage the context of objects (users) on servers, this type of management is dedicated to specific services. The ubiquitous service infrastructure maintains adequately stocked context information and functions that are available at all times to ensure a diverse range of services can be provided at any time.

Expansion of the infrastructure for the purpose of integrating wireless sensor networks, comprised of such elements as ZigBee™[*5)] or RFID, with the IP network, is being carried forward with AP@PLAT. This new infrastructure captures objects in physical space and is able to offer features for performing context conversions and transmitting processed information to information and communication systems. It is an infrastructure that gives the information and communication systems the capability to capture and control events occurring in the physical space. Furthermore, fulfillment of functions for dynamically controlling networks from information and communication systems, as well as session management and context management are also being considered, to make them available with the realization of NGN.

Conclusion

OKI has been promoting the creation of solutions that converge information services and communication services with application servers that converge Web with SIP at the core, under the information and communication solution concept of AP@PLAT. The realization of networks that are fully converted to IP is now just around the corner, with the establishment of NGN.

We intend to continue with our promotion of building platforms to make ubiquitous services easy. For this purpose, we at first expand the domain for converging both the vertical (real space and cyber space, as well as servers and clients) and horizontal (integration of different types of networks, as well as a link up of services and data) directions.

That is, we intend not only to converge information services and communication services, but also to converge cyber space with real space, as well as to converge services for homes, services for vehicles, as well as services and knowledge on the Internet known as Web 2.0.

Then, at second, we intend to convert essential functions into commonly shared components.

References

1) Nakazawa, O. and Ooba, K: "Concept of a Solution for Converging Information and Telecommunications by Oki Electric: AP@PLAT®", Oki Technical Review, Issue 201, Vol. 72, No. 1, pp. 4 to 9, January 1, 2005.
2) Sugimoto, H: "OKI's Undertakings for Next Generation Networks (NGN): Towards realization of e-Society", ITU Journal, Vol. 37, No. 1, January 2007.

Authors

Masahiro Kawahara: Systems Network Group, Network Application Div., AP@PLAT Solution Planning Dept.

*5) ZigBee is a registered trademark of Koninklijke Philips Electronics N.V.