Japanese Ubiquotous Network Project: Ubila

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1 Introduction

Recently, the advent of sophisticated technologies has stimulated ambient paradigms that may include high-performance CPU, compact real-time operating systems, a variety of devices/sensors, low power and high-speed radio communications, and in particular, third generation mobile phones. In addition, due to the spread of broadband access networks, various ubiquitous terminals and sensors can be connected closely.

However, as many researchers argue, as addressed by Weiser in 1991 [32], the real goal of ubiquitous computing remains far beyond current R&D levels. In Japan, a more pragmatic approach focused on what we called ubiquitous networking. A roadmap of such ubiquitous networking projects in Japan is depicted in Figure 1.

Ubiquitous networks cooperatively support user-centric services and applications anywhere and anytime. The Japanese Ministry of Internal Affairs and Communications (MIC) started a study on ubiquitous networking around 2000 and in 2002 issued a report on "Ubiquitous Networking" [11]. It argued that the context aware computing environments embedded in our real world interconnected by broadband fixed/mobile networks will greatly enhance services to end users and bring amenity and security to all people.

At the same time, the Ubiquitous Networking Forum [29] was founded in June 2002 mainly by Japanese communication industries to accelerate and promote studies on ubiquitous networking. The forum's objectives included the following:

1. Create new industries and business markets
2. Enable secure social lifestyles
3. Encourage social participation of the disabled and elderly
4. Support various work environments

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The forum conducted extensive studies on various aspects of ubiquitous networking, and published a white paper named “A book of DOKODEMO Network (ubiquitous network)” in 2003 [30].

In 2003, MIC launched three national research and development projects on ubiquitous networking: a microchip networking project, an authentication and agent networking project, and a network control and administration project. We were assigned to lead the last project that was named the *Ubila* project.

Followed by those three projects, MIC launched some ubiquitous networking related projects, including Network Robots Project in 2004, RFID project in 2004, and Sensor Network Project in 2005. In 2004, MIC started a policy roundtable for the future ubiquitous network society and named it “u-Japan” [13].

The Ubila project consisted of seven member companies and universities: Kyushu Institute of Technology, KDDI R&D Labs., NEC Corporation, Fujitsu Ltd., Keio University, the University of Tokyo, and KDDI Corporation. The Ubila project covered a large R&D area for supporting ambient services, and its keyword was *context awareness*. The project aimed to realize the total control and management of an ambient system.

During its five years of Ubila R&D activities, almost $40 million were funded for the project. In this section, an overview of the project and its results are introduced from various aspects.

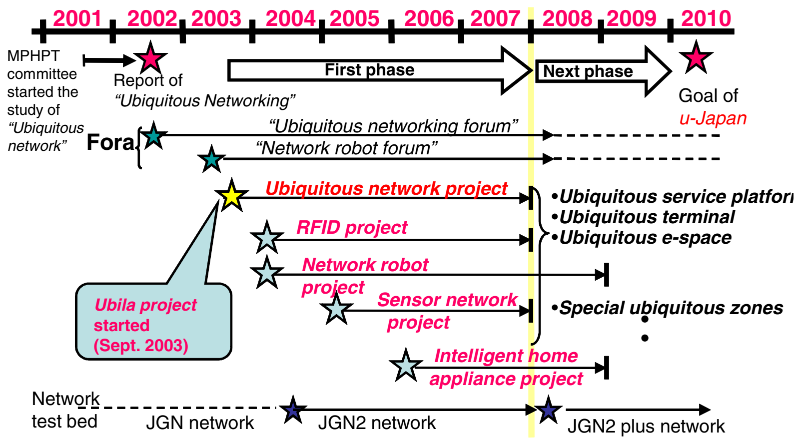

Fig. 1 The roadmap of ubiquitous networking projects in Japan

2 Ubila's Vision

The objective of the Ubila project [28] was to establish key technologies for ubiquitous networking to generate and provide optimal applications, network connections, network services, computing/network environments, and real services to end users.

A schematic diagram of the Ubila project is shown in Figure 2. Users performed daily activities in real space, which is indicated at the bottom of the picture. A ubiquitous network system tries to recognize a user's situation, or infer what a user wants or requires. Such a user's situation is called *context*, or more specifically, *user context*. Various monitoring methods such as sensors and RFID tags may be used. The retrieval flow is shown by the arrow on the left.

Information about the network situation is also simultaneously retrieved. It includes the access situation of a user wireless terminal, the connection status of the communication devices around a user, and the necessary core network traffic situation. This is called *network context*, and it is shown by the arrow on the right.

With these collected activities, a set of context is eventually created that considers both the user and the network context. Depending on their attributes, some components are named separately and differently such as profiles, feelings, policies or Service Level Agreements (SLA). Profiles include the user's pieces of information associated with user activities. Feelings are the emotional information instances of a user. Policies are network controlling rules for a user or user applications. SLA show the committed degree of network service quality. The Ubila system will exploit all of these context for a target user, decide a service scenario, and identify the necessary network control based on the user and network context. A ubiquitous network will perform various controls, such as selecting an appropriate access network, ensuring quality guaranteed routing paths, and/or finding the best resource for contents downloads, etc. Eventually service or contents are presented and provided to a target user who enjoys such services with his/her local surrounding computing environments. This environment is called the Access Open Platform, which is comprised of many home appliances, wireless units, sensors, motes and actuators that provide direct human interfaces.

3 Approach

As described in the introduction, the Ubila project had two major areas: applications/appliances and networks. Even though these two areas are normally considered independent, the Ubila project integrated them for mutual cooperation to provide ubiquitous environments to target users. Therefore, having and sharing a common vision among two areas was crucial. The Ubila project set two views: *context awareness* and *user centric*. In addition, target users were not technical experts, but ordinary people including the elderly and children to whom services, applications and network services must be provided without specific knowledge or previous ex-

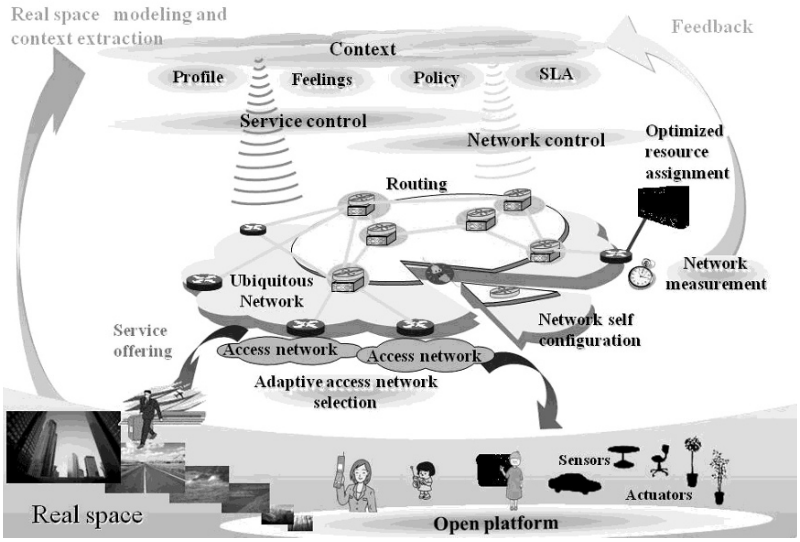

Fig. 2 Schematic picture of Ubila vision

perience. In the next section, some prototype developments of ambient services are introduced.

4 Various Ambient Service Designs and Prototypes

4.1 Basic Component Technology

4.1.1 Indoor Location System

Measuring locations in outdoor environments is now possible with GPS. However, obtaining indoor location information remains an issue for ubiquitous computing. Many indoor positioning systems have been proposed, but they still need initial system configuration. The University of Tokyo developed a fully distributed ultrasonic positioning system called "DOLPHIN" (Fig. 3). It was verified in an actual indoor environment and provided high-accuracy positioning [14] without complicated initial configurations.

4.1.2 Wireless Sensor Network Nodes

For sensing from environments or making actuations toward environments in ubiquitous computing, wireless sensor network nodes have important roles. Although

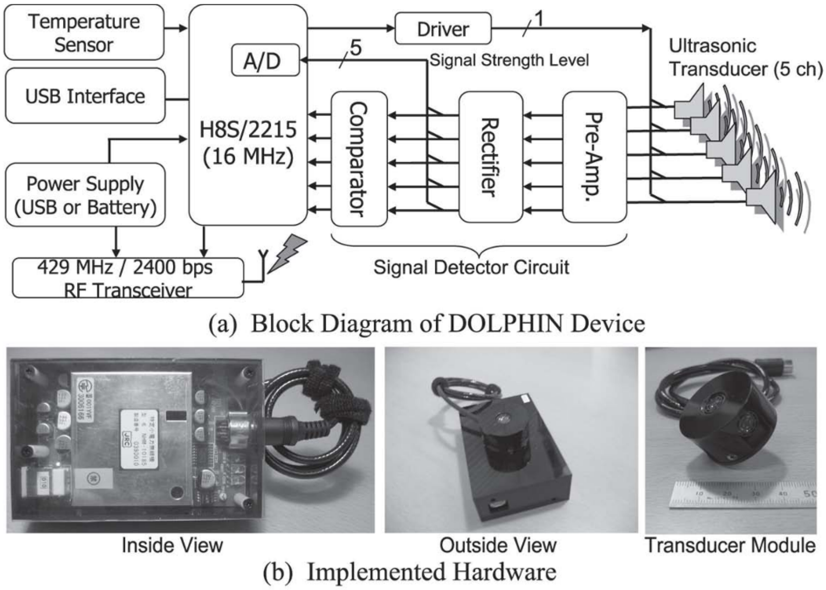

Fig. 3 Block diagram and implementation of DOLPHIN

motes with TinyOS are now widely available, they still have issues related to supporting real-timeness and programming flexibility. With a real-time OS, the university of Tokyo developed wireless sensor network [21] called "PAVENET" and "PAVENET OS" (Fig. 4).

"PAVENET OS" provides a hard real-time process and yet can operate with very small resources. For example, exact 100 Hz real-time sampling while communicating with other nodes is ensured with "PAVENET OS".

"ANTH," a device collaboration framework for sensors and actuators using "PAVENET," detects events from sensor objects on an event-driven basis and passes them to actuator objects. Making a bind between objects may be done by just attaching two physical objects.

4.2 Pilot Applications and Services

In this subsection, demonstrations of pilot applications and/or field trials are described. Through those demonstrations and field trials, they verified performance and service possibilities.

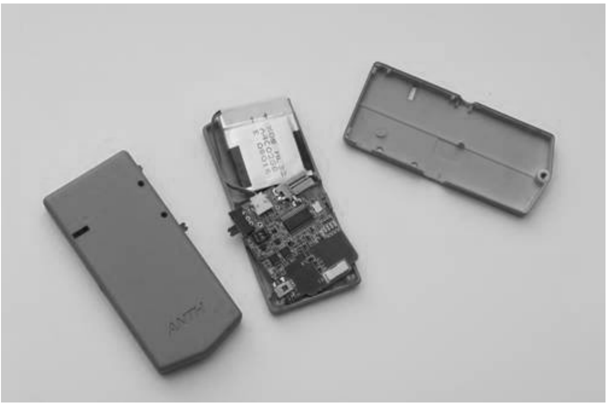

Fig. 4 PAVENET module: wireless sensor network nodes with real-time OS

4.2.1 Earthquake Sensing System

An earthquake sensing system was developed in collaboration with Kajima Corporation and the University of Tokyo [24] (Fig. 5) to measure vibrations caused by earthquakes using acceleration sensors embedded in buildings or bridges.

During an earthquake, all sensors start to measure the acceleration and send the data to a sink node. A "PAVENET" module was used for data collection. Synchronization errors were supressed within 1 msec.

This system will be useful to check whether a target building remains robust against earthquakes or needs reinforcement.

4.2.2 Smart Furniture

smart furniture, an initiative to make our living objects smart, was aggressively developed by Keio University. Such furniture takes an important role for realizing smart space or providing ubiquitous services.

Among the developed smart furniture, the most useful prototype is "uTexture" [10] (Fig. 6), a kind of panel computer with touch sensors that can be connected with each other to learn mutual connection topology. "uTexture" is programmable; it could be a tiled display or a CD audio player (*Media Shelf*), etc.

This furniture was embedded in the smart space in Yurakucho, Tokyo and several key applications were demonstrated with it (see 7.2).

"MO@I" is another good example of smart furniture [4] (Fig. 7). It is basically a big screen with a touch sensor, a USB camera, an ultrasonic sensor, an LED, and RFID (passive and active) readers. Since several local interfaces have different coverage, "MO@I" may have different service zones, namely, touchable, face to face, visible, and ambient zones, and services are provided according to the user registered zone.

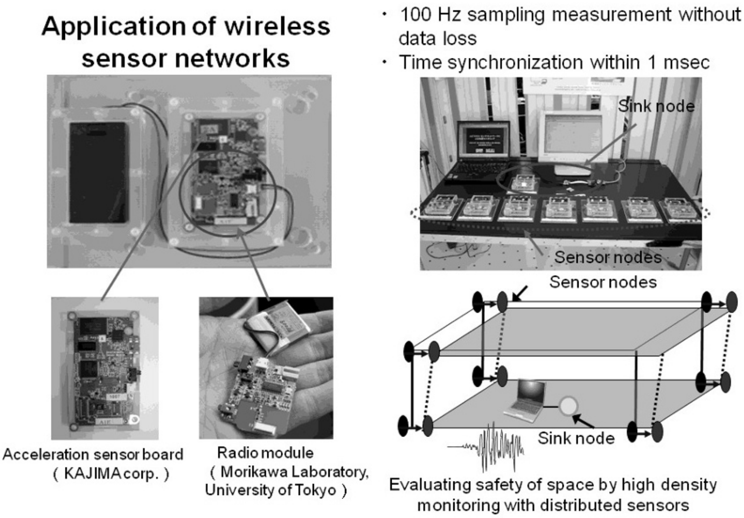

Fig. 5 Earthquake sensing system with "PAVENET" module

Fig. 6 Smart furniture; uTexture

4.2.3 uPhoto

"uPhoto" was designed to add *tags* to visible spaces [5, 23]. Normally, available services in an environment are not explicitly indicated. "uPhoto" searches for available services in an environment from a photograph. Services embedded in an environment are marked with special identification tags called "service eyemarks" and

Fig. 7 Smart furniture; MO@I

registered to a server. After a photo is taken, they are sent to a server to search and find available services within the picture.

This service resolution is made immediately after the picture is taken, and available services are indicated on the picture. Therefore, by clicking the icon on the screen, target service can be invoked. "uPhoto" was developed by Keio University.

Fig. 8 uPhoto: finding avilable services from a photo

4.3 Collection and Dissemination of User Profiles

If so much information about the real spaces or daily objects is collected and disseminated over an entire ubiquitous network, then innovative values can be created.

Among such information, user information or p user status information is important (see 9.1). We call this “user context” or “user profiles.”

In this subsection, several R&D outputs are described that exploit user profiles.

4.3.1 *Kuchikomi* Navigator

“*Kuchikomi* navigator” collects users’ views or short comments about things, analyzes them by on-demand community network engines, and visually shows the results (*Kuchikomi* means “a word of mouth communication” in Japanese). If a user selects a specific topic, then related topics are automatically sought by the engine and presented on the PC display based on their similarity. They collected *Kuchikomi* sources from the Internet and also took Lifelog (see in 4.3.3) as an input source.

The community network engine dynamically establishes an on-demand secure link among relevant nodes called the Closed User Group (CUG). “*Kuchikomi* navigator” was developed by NEC.

4.3.2 Home Navigator

“home navigator” is designed to control intelligent home appliances based on a context aware module. It was jointly developed by the University of Tokyo and NEC. The module consisted of “Synapse” and a policy engine. “Synapse” anticipates and suggests subsequent actions for home appliances, based on a previously learned typical sequence of user operations associated with sensor data [22].

A policy engine specifies a set of appliance execution policies. For example, prohibiting the simultaneous operation of both a heater and an air-conditioner in one room is a policy. Combining two engines can offer context aware services that comply with specified rules.

4.3.3 Lifelog with Mobile Phones

Using mobile phones, KDDI developed a lifelog system called “*Keitai de* Lifelog (Lifelog with mobile phones)”. Current mobile phone has many capturing capabilities, such as camera, barcode reader, and obtaining locations with GPS, and even RFID reader may be feasible. In this sense, a mobile phone is an ideal object to collect a personal profile of a user’s daily life.

This Lifelog system regards incidents that happen around a user as pieces of lifelog and captures them by mobile phone. For example, when a user goes shopping and finds an interesting goods, then he/she may get many information, i.e., when, where (by GPS), what (by taking a photo and/or by reading a barcode or 2-D barcode (QR code)), etc [15]. Detailed information on the object (name, vendor, price, etc) may be resolved from the barcode on the object with a help of common product database.

Fig. 9 Home navigator: smart controller for intelligent home appliance

After being uploaded, the record is stored semantically using the Resource Description Framework (RDF) format, where all resources in real space are individually assigned a unique URI.

At the same time, KDDI developed a mobile phone with a passive RFID reader [9] (Fig. 11). In demonstrations, RFID tags were placed on objects, and when an identification number was read out from the RFID, the object's attributes (e.g., name, location, price, etc.) were resolved by a server and stored in RDF format.

The stored data can be shown to a user in several styles including a blog, a calendar or mashed-up format on a map.

4.3.4 Real-space Collaborated Presence Service

Presence sharing is one of the most popular applications in the ubiquitous computing environment. If buddies' presence is shared, they can know more about each other and can use the presence as a trigger for new communication. The University of Tokyo and KDDI R&D Labs. developed a TV presence sharing system between smart spaces and mobile phone.

The configuration of the presence service is depicted in Figure 12. Each user has his/her own presence server in which his/her TV presence is collected and kept. The presence information is exchanged between presence servers according to the buddy lists using SIP-based protocol.

In their implementation, a smart remote control box in a smart space collects a presence which TV program is being watched by a user, and uploads it to a presence server, while a mobile phone can also collects presence of buddies through his/her presence server.

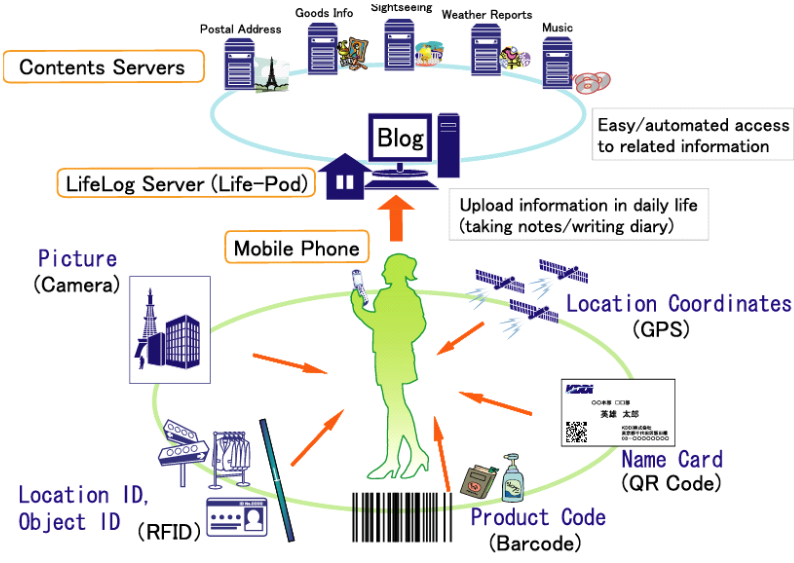

Fig. 10 Lifelog: collecting users' daily information with mobile phone

Fig. 11 Mobile phone with RFID reader: passive RFID tags can be read out with a mobile phone

An example sequence is as follows: when user A shows his presence that "I am watching TV program X" through A's presence server, then a user B can get and view user A's presence through B's mobile phone. The user B may start to watch the same TV program X with B's mobile phone or user B may power on the TV using the mobile phone as a TV remote controller.

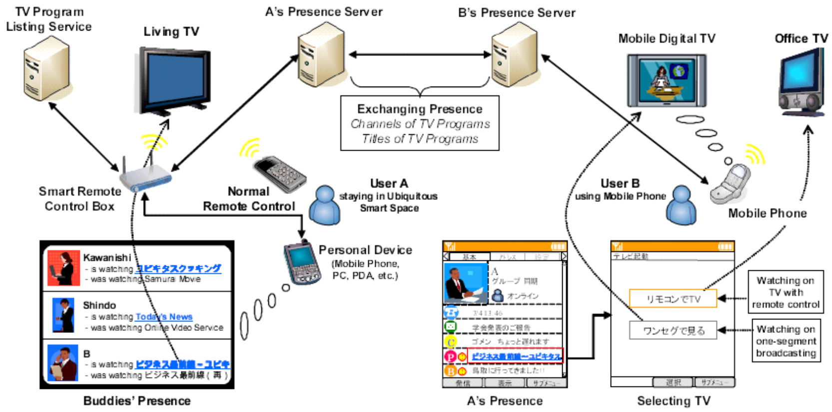

Fig. 12 Real-space collaborated presence service

4.3.5 "*Kansei*" Service

"*Kansei*" (it means "feelings" in Japanese) service is a prototype system developed by Kyushu Institute of Technology to find users who share similar feelings. In the "*Kansei*" service, users are given a set of vectors that represent their feelings that is uploaded to a P2P (Peer to Peer) network PIAX (see in 11). During a query process of a P2P network, the system automatically controls and guides a query propagation to network nodes whose feeling vectors resemble the original query node. Thus the user who originated the query can easily locate users (P2P network nodes) with similar feelings [17].

5 Field Trials

In this section, several field trials using developed prototypes are reported.

5.1 Live Commerce Akiba

"Live Commerce Akiba!" was jointly held with UNS2007 in the city of Akihabara, Tokyo, and operated by Keio University and the University of Tokyo.

Keio University developed an extended smart furniture sensor board (see in 4.2.2) to measure the popularity of goods in stores. They installed sensors on goods and if a user touches or picks it up, then a sensor detects the motion and interprets it as a sign of interest (Fig. 13). A signboard showed the accumulated interest value with photos of the goods, allowing users to learn which were popular. At the same time, the data were sent to the Point of Sale (POS) system of the store. Mobile phones and figures were displayed for this trial.

Fig. 13 Live Commerce Akiba: measuring the popularity of goods

5.2 Temperature Monitoring with Airy Notes

"Airy Notes" system monitors environmental conditions using tiny sensor modules with wireless communication capabilities. Each sensor module can measure environmental parameters including temperature, and the data are collected and sent to the sink node. The obtained characteristics of the target area are shown on a map and can also be seen by mobile phone.

The Keio University team conducted a field trial with about 160 sensors at Shinjuku Gyoen Garden, which is located very close to the Shinjuku area, a highly urbanized part of Tokyo. The results of the field trial demonstrated that the temperature of the garden area was lower than the edge of the garden, verifying the greening effect of the urban area [3] (Fig. 14).

5.3 Lifelog Trial

The Lifelog project was introduced in Section 6. In 2007, a field trial was conducted in Tochigi prefecture with the Hakuyo Agricultural High School to promote e-agriculture. Lifelog provided support by using mobile phones to record farming processes, i.e., when crops were planted, when and how much fertilizer or chemicals were used, when the crops were harvested, etc (Fig. 15). By making such farming

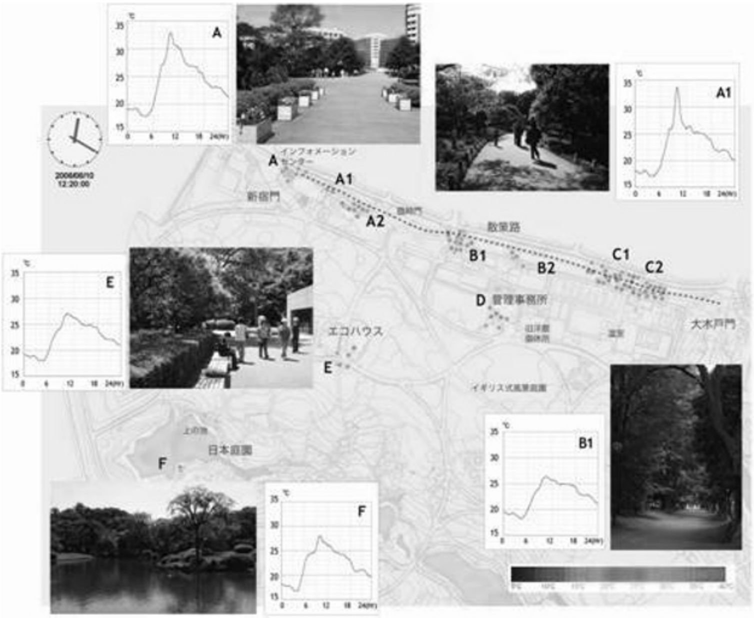

Fig. 14 Airy Notes field trial in Shinjuku Gyoen

processes transparent to consumers through the Lifelog, consumer confidence in the quality of farm products may increase.

Fig. 15 Lifelog trial for e-agriculture: work record is displayed with mashed up format

6 Creation of Videos

6.1 Motivation

The Ubila project created two videos, “Small stories in 2008” in 2003 and the other is “Aura” in 2007, which are available at `http://www.ubila.org/e/e_index.html`.

A word “ubiquitous” was not recognized well in Japan when the Ubila project started in 2003. To promote the actual concept of “ubiquitous computing” to all people by showing how ubiquitous technologies can implicitly and invisibly support their daily lives, Ubila members joined a special working team of the Society of Ubiquitous Information[1] and created promotion videos.

The process of making videos played an important role because it created a common vision of ubiquitous computing that could be shared by all members. The rough process includes the following four steps: (1) retrieval of knowledge about the target domain, (2) visualization of structure between obtained knowledge, (3) creating scenarios, (4) and making the video.

In steps (1) and (2), a workshop was held in which 14 participants brainstormed futuristic topics by viewing about 200 randomly chosen news articles. The futuristic topics were considered scenario seeds. All participants generated scenarios under specific future situations. For example, how would enhanced sensor networks that can even monitor the detail of peoples’ activities affect young peoples’ daily lives at Shibuya (Shibuya is a lively spot in Tokyo).

Those topics and derived scenarios were integrated into a visionary map indicating mutual relationships. Finally a consolidated video scenario was composed based upon the map using a toolkit [18].

The significance of these processes was to create an aggregated future vision by converting informal knowledge of experts into formal expressions. In the final scenario, such knowledge, i.e., collective intelligence, was well reflected as well as the author’s view.

6.2 First Video: Small Stories in 2008

The first work, which was made in 2003, was called “Small Stories in 2008” and consists of three short stories, with technologies available in 2008. The first, “Love Triangle,” featured advanced urban communication infrastructure by exchanging location information and/or presence information among friends or communities. The second one, “First Love,” featured a community computing in an educational environment. iThe last one, “The Reunion,” described the extension of communication and service resources in a nomadic environment.

[1] Private study group of ubiquitous computing in Japan headed by Tomonori Aoyama, Keio University

Fig. 16 Video; Small Stories in 2008 (2003)

6.3 Second Video: Aura

The second video, “Aura,” was made in 2006. Its intention was to send messages to people how we envisage the era of 2015, considering the progress of ubiquitous/sensing technologies.

The working group took the same approach as in “Small Stories in 2008.” They chose three topics as the basis of the story: enhancement of personal skill and performance, activation of community communications, and improvement of social welfare.

“Aura” basically showed the future convenient and amenity lifestyles, and a life surrounded by many sensors and devices was also demonstrated, posing questions about who has the right to capture and use the sensed data and/or how to protect people’s privacy under such environments.

Fig. 17 Video; Aura (2006)

7 Building and Operating Smart Spaces

To give people chances to see the output of R&D, the Ubila project set up three *smart spaces*, two in Tokyo and one in Kokura, Kitakyushu. The spaces ran from 2005 to 2007. The Ubila project periodically conducted open demonstrations to show their latest developments. All smart spaces were interconnected with Japan Gigabit Network 2 (JGN2) which is a national open testbed high-speed network [6].

7.1 Akihabara Smart Space

Akihabara, one of the largest areas in Japan for buying various kinds of electronics, computers, software, and animations, is also known as a collaboration place between academia and industry. The Ubila project installed a smart space in the Akihabara Daibiru building in the center of Akihabara. The space, which was mainly operated by the University of Tokyo, was designed by Hiroshi Shoji and generated a futuristic atmosphere that included meshed type ceilings and spaces separated by many portable poles (Fig. 18). There were hollow spaces within poles where sensors and various devices and power and network cables could be freely installed. Such flexible features of the space enabled various kinds of field trials and demonstrations using developed R&D outcomes.

The space was also used for such joint activities as collaboration with Ubiquitous Networking Forum in which Sensor Network Committee jointly conducted demonstrations with the Ubila project [29]. A total of 14 demonstrations were conducted.

7.2 Yurakucho Smart Space (uPlatea)

The Ubila project set up another demonstration and experiment space in Yurakucho, Tokyo, named “uPlatea” [31] (“platea” means a plaza or a place in Latin). uPlatea was designed to invisibly embed many computers, sensors, and network devices in harmony with conventional furniture. Since uPlatea could be used as a smart meeting space, a smart public space, or a smart living space, it could be used for ubiquitous service experiments in various life scenes. Smart panels called “uTextures” (see in 4.2.2) were placed in this environment. They were flexibly configurable and might work in many ways such as multi-tiled displays, CD music players, or smart bookshelves. Ten demonstrations were conducted and welcomed hundreds of visitors.

7.3 Kitakyushu Smart Space

The third space was built in Kitakyushu, located hundreds of miles away from the other two spaces. This space served as an experimental network hub station in which JGN2, Science Information Network (SINET), commercial ISP, and Kyushu Institute of Technology were interconnected to realize multi-home environments.

In the Kitakyushu smart space, several field trials and demonstrations were conducted for network self configuration, wide area distributed computing, on-demand network quality control subproject for end-to-end QoS, etc.

8 Network or Protocol Oriented R&D

Universal accessibility is a crucial feature of ubiquitous networks, even though basic accessibility is now well-established through fixed broadband access and third generation mobile services. However, ubiquitous networks are comprised of various devices, including sensors, actuators, robots, and terminals with a variety of communication capabilities. Therefore issues exist about how such ubiquitous nodes exchange data or information with a small number of protocols.

Network control and management were also important research items of the Ubila project. The network status itself may be regarded as "network context." For

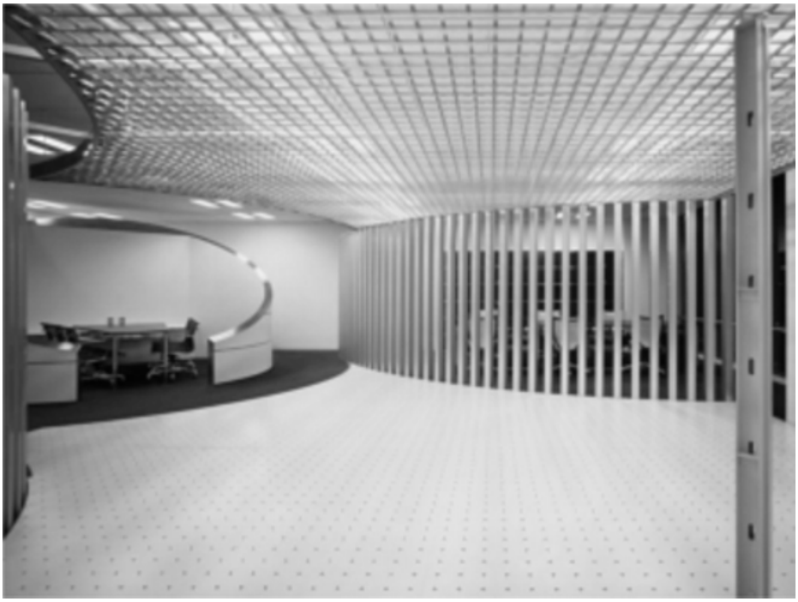

Fig. 18 Akihabara Smart Space

Fig. 19 Yurakucho Smart Space: “uPlatea”

users to enjoy ubiquitous services using remote resources through networks, such network attributes as bandwidth, packet loss rate, or latency, need to be controlled based on network context.

In this section, we show some Ubila R&D activities from the viewpoint of network and protocol issues.

8.1 Protocol Enhancement: OSNAP and CASTANET

Sensor nodes are normally tiny devices that do not have full access capability to networks. The TCP/IP may not be supported. A protocol called “OSNAP (Open Sensor Network Access Protocol),” which connects sensor nodes to internet, was proposed by the Sensor Network Committee of the Ubiquitous Networking Forum [20]. When the TCP/IP is supported either at sensor nodes or gateway, the data of the sensor nodes can be accessed with this protocol. OSNAP is based on the Simple Network Management Protocol (SNMP), and sensor nodes may be regarded as network nodes to be managed.

Another concept called “CASTANET” was proposed by the University of Tokyo [8]. It requests that the access methods of all ubiquitous nodes comply with the Representational State Transfer (REST) architecture style, whose popularity is becoming on the Internet. With CASTANET, sensor data obtained from sensor nodes and commands for driving actuators can be handled with HyperText Transfer Protocol (HTTP).

8.2 Adaptive Network Control Based on Network Context

Network context generally reflects the network state. The local network context may be easily obtained by measuring its performance locally. However, measuring network context over wide inter-domain networks is difficult. In the Ubila project, Kyushu Institute of Technology and KDDI R&D Labs. developed a network QoS measurement method based on a network tomography. With this method, sparsely placed network measurement nodes can estimate the global network performance and if anomalies happen, they can be identified.

Fujitsu developed QoS control and routing control systems using a network administration and control server (Fig. 20). The server reserves a certain volume of network resources in advance. When it receives a QoS control request from a user, the server searches for the available network resource from the reserved ones and assigns the resource adaptively based on the request level over the inter network domain [19].

Fujitsu also implemented a web service interface to control network QoS. The interface is described with Web Service Description Language (WSDL) and requests are sent by Simple Object Access Protocol (SOAP). The system was tested and verified to work on the JGN2 network testbed.

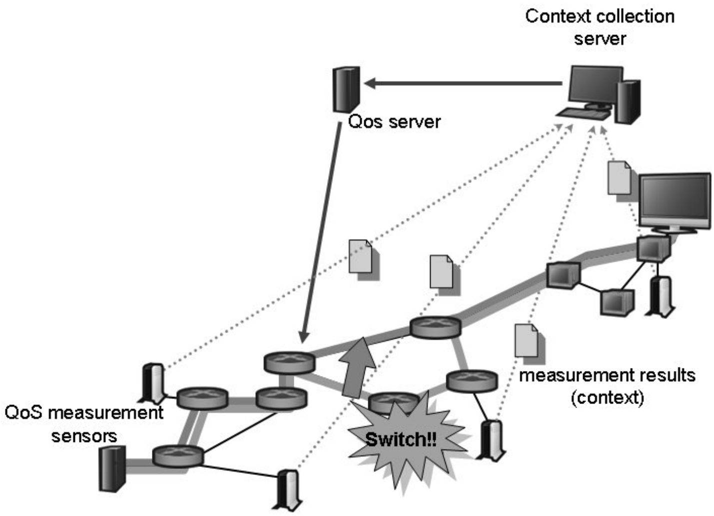

Fig. 20 Adaptive Network Control: network context is collected at Context collection server and QoS server will control network routing

8.3 Automatic Network Configuration

Network connection topology is a part of network context. Ubiquitous network nodes may sometimes move nomadically. One necessary feature for ubiquitous networks is that network nodes can be instantly connected and configured to a network based on a assigned network policy and context without complicated manual procedures.

The KDDI R&D Labs. developed a centralized IP router setup protocol called "Router Auto-configuration Protocol (RAP)." If an IP router supports RAP, then it can be configured to an IP network with few settings.

9 Defining Context Aware System Architecture

9.1 Ubiquitous Network Architecture and Context

As readers may know, the formal definition of the context awareness remains elusive. In addition, the Ubila project often received requests to clarify ubiquitous network architecture. Although many researchers discussed ubiquitous networks, few clearly defined *context*.

The Ubila project established a study team on context awareness and network architecture and issued an account called, "A report on a ubiquitous network architecture" (in Japanese) and made it public through the Ubiquitous Networking Forum [30]. The proposed network architecture is shown in Figure 21. Its functional architecture consists of a ubiquitous network (in a narrow sense), network control function, a service control function, context collection and dissemination functions and an access open platform. The bottom line is that context has a central role in the system, and by appropriately applying context to both service and network control functions, optimal service can be offered to users. The architecture was found to be well suited to all Ubila members' service scenarios.

The next study defined *context* based on Dey's somewhat recursive definition, "any information used by context-aware servicies" [1], and classified context into primary and secondary parts. Primary context is a kind of raw data typically obtained from sensors or network monitors that is readable by computer. RFID identifications, user input profiles, and the amount of network traffic are examples of primary context. Secondary context is semantically inferred data from primary contexts based on target applications. For example, the estimated inventory status from RFID data in stock control applications is secondary context.

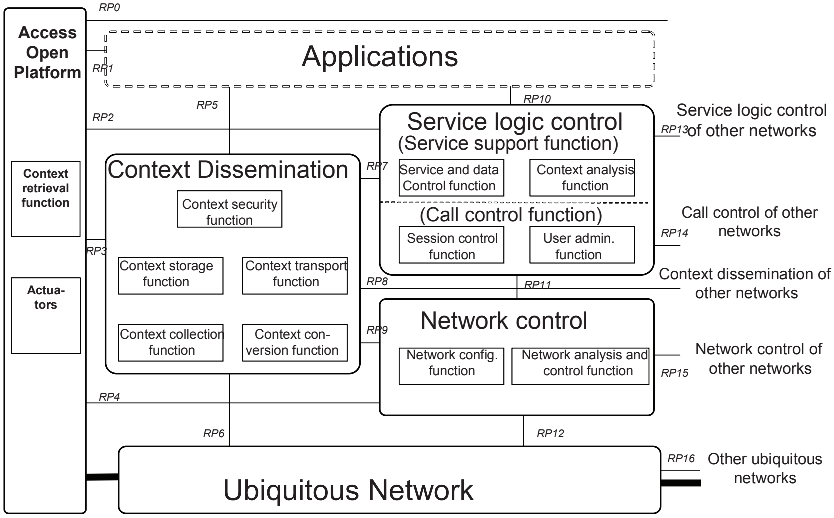

Fig. 21 Proposed ubiquitous network architecture

9.2 Contributions to ITU-T

Based on the study on context awareness, Fujitsu, NEC, and KDDI proposed ITU-T SG13 to incorporate "context awareness" as a next generation network (NGN release 2) requirements.

In NGN release 1 requirements, "presence" was incorporated to show a user's situation. The contribution proposed to treat "context awareness" as an expanded and general concept of presence and could be used for various NGN service provisions.

After discussion, the concept was understood, and the Jan. 2008 SG13 meeting in Seoul agreed to incorporate this requirement in "Y.NGN-R2-Reqts."

10 Symposium and Contributions to Academia and Fora

To demonstrate R&D output of the Ubila project, Ubiquitous Network Symposiums (UNS) were held every year. The first UNS was held in 2004 at Odaiba, Tokyo with about 300 participants. UNS2005 was held in the Kyoto International Conference Center, Kyoto. UNS2006 was not independently held but had booths and a conference at CEATEC JAPAN 2006 at Makuhari, Chiba (Fig. 22). As a final event, UNS2007 was held in Akihabara in October 2007. At UNS2007, all ongoing ubiquitous national projects met to demonstrate their research results.

During its ongoing period, the Ubila project contributed to many academic activities. The biggest was *Ubicomp2005*, held in Tokyo [27]. Prof. Hide Tokuda, Keio University, served as a general chair and many Ubila members and member organizations supported this successful conference that was attended by 625. The conference showed the Ubicomp records so far.

In addition to Ubicomp, another international conference emerged from Japan: the International Symposium on Ubiquitous Computing Systems (UCS). UCS2003, the first UCS, was an intimate affair held in Kyoto. UCS2004 was held in Tokyo and welcomed international participants. In 2005, a workshop was held in Cheju, Korea, instead of UCS. In 2007, UCS2007 was jointly held with UNS2007. Participants could see the outcome of the Ubila project.

The Ubila project also had a close relationship with fora in Japan. The first was "Ubiquitous Networking Forum" created in 2002 that helped national projects by collecting research results and/or documents as candidate material for standardization and made them public.

The "Network Robot Forum," another forum activity, focused on network robot R&D activities. A protocol *CroSSML*, which connects a ubiquitous network and a network robot was proposed by the Ubila project and verified its usefulness within the forum.

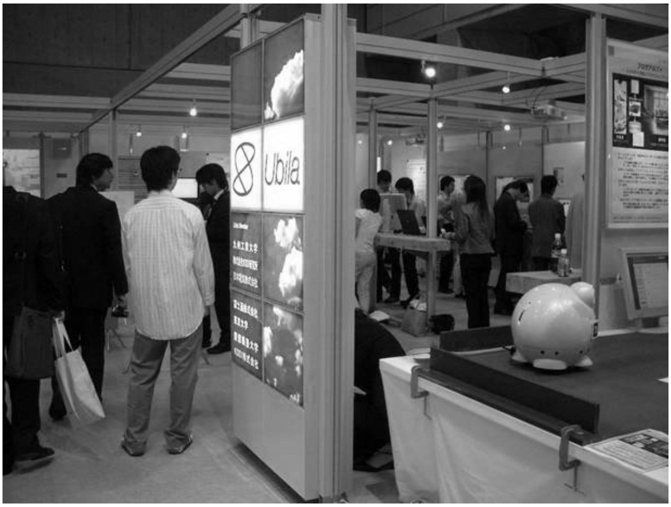

Fig. 22 Booth of the Ubila project at CEATEC 2006

11 Related Activities and Future Trends in Japan

11.1 National R&D Projects in Parallel to Ubila

As shown in Figure 1, there are many ubiquitous related activities in Japan. Alongside the Ubila project, two other projects were operating in parallel. One was the Ubiquitous Authentication and Agent project (UAA) headed by NTT [26]. They conducted R&D on authentication technology under ubiquitous environments and developed a P2P platform named P2P Interactive Agent eXtensions (PIAX) on which many agents may run and exchange information on a peer-to-peer basis [7].

Another project was headed by YRP Ubiquitous Networking Laboratory and called "A Study on Ultra Small Chip Networking Technology." Its mission was to develop ultra-small scaled network nodes, i.e., super small active identification tags. The developed tags were named "dice" and were about 10 mm^3. These tags were deployed in a number of ubiquitous field trials. For identification, they proposed a unique identifier for RFID called "ucode."

11.2 Other Ubiquitous Computing Related R&D Projects in Japan

There were some other major ubiquitous computing related projects in Japan. Before the Ubila project was launched, there were preceding ubiquitous computing Projects.

One was a "Cyber Assist Project for Ambient Intelligence" at CARC (Cyber Assist Research Center) from 2001 by AIST, National Institute of Advanced Industrial Science and Technology [16]. They tried to realize ambient intelligence using IPT (Information Processing Technology) to resolve the issues of "information overload," "digital divide" and "privacy protection".

The other one was "Yaoyorozu project" [33][2]. The project was conducted from 2002 to 2005, and was supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT). They took an approach to resolve issues through a combination or fusion of engineering, the humanities, and social sciences.

There are also ongoing projects related to ubiquitous computing.

The "Free Mobility Assistance Project" has been conducted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) since 2003 for the support of universal mobility. They made a number of field trials nationwide to verify the mobility support using RFID tags. One example of the trial was "2009 Tokyo Ubiquitous Technoloty Project" performed in Ginza, Tokyo [25].

"Information Grand Voyage" is a currently ongoing big ICT project which aims to develop a next generation information retrieval / analysis technologies and tries to

[2] The name "Yaoyorozu" is interesting since in classical Japanese it literally means "so many gods are everywhere and protecting us," see `http://www.8mg.jp/en/outline_origin01.htm`

verify them through model services. It is supported by Ministry of Economy, Trade and Industry (METI). The project started from 2007 and planned to complete in 2009 [2].

11.3 Next Phase

MIC Japan set the year of 2010 as the target date for u-Japan [12]. By this time it is expected that technical solutions should be readily available for resolving many current issues including ensuring public safety, disaster prevention, preserving the environment, conserving energy, and supporting the elderly, the disabled, and children.

Those wide area requirements lead to a second phase ubiquitous networking project for integrated platforms to provide adaptive ubiquitous services that are easily customizable for end-users With these perspectives, in 2008 a second phase project called the “Cross UBIQuitous platform project (CUBIQ)” started to build an integrated platform in which adaptive ambient capabilities are easily provided to end-users.

12 Conclusion

The Ubila project ended in March 2008. During its five years, more than 100 people were involved and presented unique activities with a close relationship among industry, academia, and government. The items in this article are just samples of Ubila R&D results . Many of the network related R&D achievements were omitted from this article. So far, 42 journals and 640 articles have been published and 108 patents have been filed.

All Ubila members are convinced that the project was an important and significant step toward the realization of ubiquitous paradigms.

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