Home Network & Networked Appliance Technology

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Abstract

This article presents an overview of an adaptable platform for integrating applications and services using broadband access in the home that opens the way to innovative solutions by linking networks and services and by linking services to other services. It also describes recent appliance-related developments that have inspired new services and discusses research and development directions in this area.

1. Background trends and development issues

1.1 Deployment of broadband access

The growing popularity of mobile phones capable of connecting to the Internet has pushed up the number of Internet users to 80 million, close to 60% of the population. Especially remarkable is the number of contracts of broadband access (DSL, cable Internet, FTTH, wireless, etc.), which reached the 15 million mark by the end of 2003 (DSL: digital subscriber line, FTTH: fiber to the home). Considering that each contract represents several users, it is estimated that some 33.7% of Internet users are broadband access customers.

The rapid emergence of this broadband access is closely related to the national IT and ICT-related strategies (IT: information technology, ICT: information and communication technology). Japan's pioneering e-Japan Strategy of 2001 elevated the deployment of a broadband infrastructure to the highest priority. The plan called for an environment that would support up to 30 million high-speed Internet subscribers and 10 million super-high-speed Internet subscribers. This target environment itself has already been achieved.

After 2003, this was followed by a succession of initiatives including *e-Japan Strategy II* seeking to take fuller advantage of IT technology, the *e-Life Initiative* promoting commercialization and wider use of networked appliances, and the *u-Japan Initiative* fostering the ubiquitous information society. The point to be emphasized here is that, although an infrastructure that could accommodate up to 40 million broadband access contracts was put in place, the actual number of contracts did not exceed 15 million. In other words, this environment is currently being under-utilized. This under-utilization can be attributed to the fact that services have not reached a level that is completely satisfactory, which highlights the importance of issues such as how the infrastructure can be better utilized and how services can be better tailored to the needs of users.

Let us first review the types of services that have been proposed. The e-Japan Strategy II initiative focuses on seven key areas where IT can be more effectively utilized:

- Medical services: promote more widespread use of electronic receipts, etc.
- Food: develop traceability systems, etc.
- Lifestyle: develop home health management systems, etc.
- Small and medium enterprise financing: promote assignment of obligations by electronic means, etc.
- Knowledge: promote e-learning, etc.
- Employment and labor: provide better employ-

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ment information through public-private collaborations, etc.
- Public services: construct and deploy portal sites, etc.

Based on this initiative, considerable research and development is focusing on technology leveraging IT in these seven key areas, which all have a direct impact on the general public.

Let us next look at the objectives of the e-Life Initiative, which is seeking to promote more widespread dissemination of networked appliances. In contrast to the old materialistic three 'C's of the 1960s (car, cooler, and color TV), the new three 'C's that are the foundation of the strategy for disseminating networked appliances are concerned with the less tangible area of information. The new three 'C's are:

- Communication: effective utilization of communication between family members and between business people in the home and office and outdoors
- Control: implementation of user friendly and easy-to-operate networked appliances
- Content: effective utilization in content-related businesses, education, and life-long learning

1.2 Growing number of networked devices

We have seen a shift in emphasis of R&D of home networks and appliances to focus on research of appliances and devices that can be connected to telecommunication networks and home networks and the development of services enabling all these devices and appliances to be operated as a single system. Indeed, considerable progress has already been made in developing and refining a range of different kinds of appliances. Here, I will take a closer look at three categories of devices: information-communications equipment, audio-visual (AV) appliances, and white goods and environmental appliances.

(1) Information-communications equipment

Information-communications equipment, which has always involved network connectivity, is no longer the simple communication tool it once was. The R&D emphasis has now shifted to linkages with different media (media centers supported by media servers), endowing phones that used to support only speech with Internet connectivity, and enabling linkages with the Web and email (NTT DoCoMo's i-mode and NTT East&West's L-mode). In this area, the convergence of different functions has become a major trend, and one important issue is how to make new terminals that combine different functions more user friendly and easier to use.

(2) AV appliances

Although they have never been networked in the past, AV appliances such as TVs and audio equipment can utilize all the rich content on the Internet if they are given the ability to interconnection with networks. And with HDD (hard disk drive) and DVD players being operated as broadcast servers, we are also seeing a trend toward seamless sharing of content between broadcasting and communication.

(3) White goods and environmental appliances

Interconnecting white goods to the network opens up the possibility of all sorts of novel uses. For example, one can download a recipe to a microwave oven or check and see what one has stocked in the refrigerator. And recently, a system enabling someone to monitor the opening and closing of a refrigerator from a remote location and monitor the activities of someone who is home (say an elderly relative who is becoming less independent) has attracted considerable interest.

In addition to these schemes for connecting terminals and equipment, another area of great interest is network control in which a device is connected to the network. For example, consider sensors. Considerable progress has already been made in developing a range of sensor-based services for pinpointing position, surveillance, monitoring, and so on using acceleration sensor chips intended for installation in communication terminals, sensor nodes connecting various kinds of sensors to networks, and sensor-based networks using these sensors.

Turning to the area of IC (integrated circuit) tags, we have seen an enormous expansion of novel service linkages by connecting tag readers to the network. This offers an easy way to attach information to objects, enabling IC tags to be used to trace food products, for example.

1.3 Technology development issues

In an environment where all sorts of devices are networked in the home, the workplace, and other places, the question of how these devices are interconnected is a matter of great concern. Currently, standardization of these networking issues—including the interconnectivity of home networks—is being defined by several different standards-making bodies. Standards generally deal with two kinds of objects: layered models of protocols and the devices covered by a standard. The layered models address framework differences including applications (ensuring interconnectivity), protocols and middleware (data format, data exchanges protocols, etc.), and physical properties (physical media, signal schemes, etc.). The devices covered by the standard include information-communication systems (personal computers, telephones, fax machines, etc.), AV components (TVs, HDD players, audio equipment), and white goods and environmental systems (refrigerators, air conditioners, sensors, etc.).

Many standards organizations are already involved in this work, but although some progress has been made in specifying interconnectivity between devices, the standardization of the layered model is still a long way off (**Fig. 1**). Nevertheless, since the devices and layered model are closely interrelated, some resolution is urgently required.

As services become more diversified and home networks and appliances become more complex, issues of how these devices can be made easy to master and how advanced services can be easily provided are critical in terms of development.

2. Efforts to date

Next, let us consider the NTT R&D initiatives to date in light of the above background.

2.1 Accommodating diversified equipment and devices

A fundamental approach that will accommodate the proliferation of more diversified equipment and devices is to base home networks on the concept of an *open service platform*. This is essentially a system in which various kinds of program modules can be deployed on the open service platform and equipment and devices connected to the network can download the program modules that they require. This approach effectively prolongs the life cycle and extends the functionality of the equipment and devices.

Efforts have been focused on the development of the Open Service Gateway Initiative (OSGi) with primary emphasis on refinement and application development. The OSGi Alliance was established in 1999 to draft and promote open service platform specifications. It currently has 40 members. On the domestic front, the OSGi User Forum Japan was established to promote more widespread use of the standard from the user side. Through R&D efforts, it is helping disseminate the standard while cooperating in standardization activities.

The standard developed by the OSGi Alliance is called the OSGi Service Platform. The specification

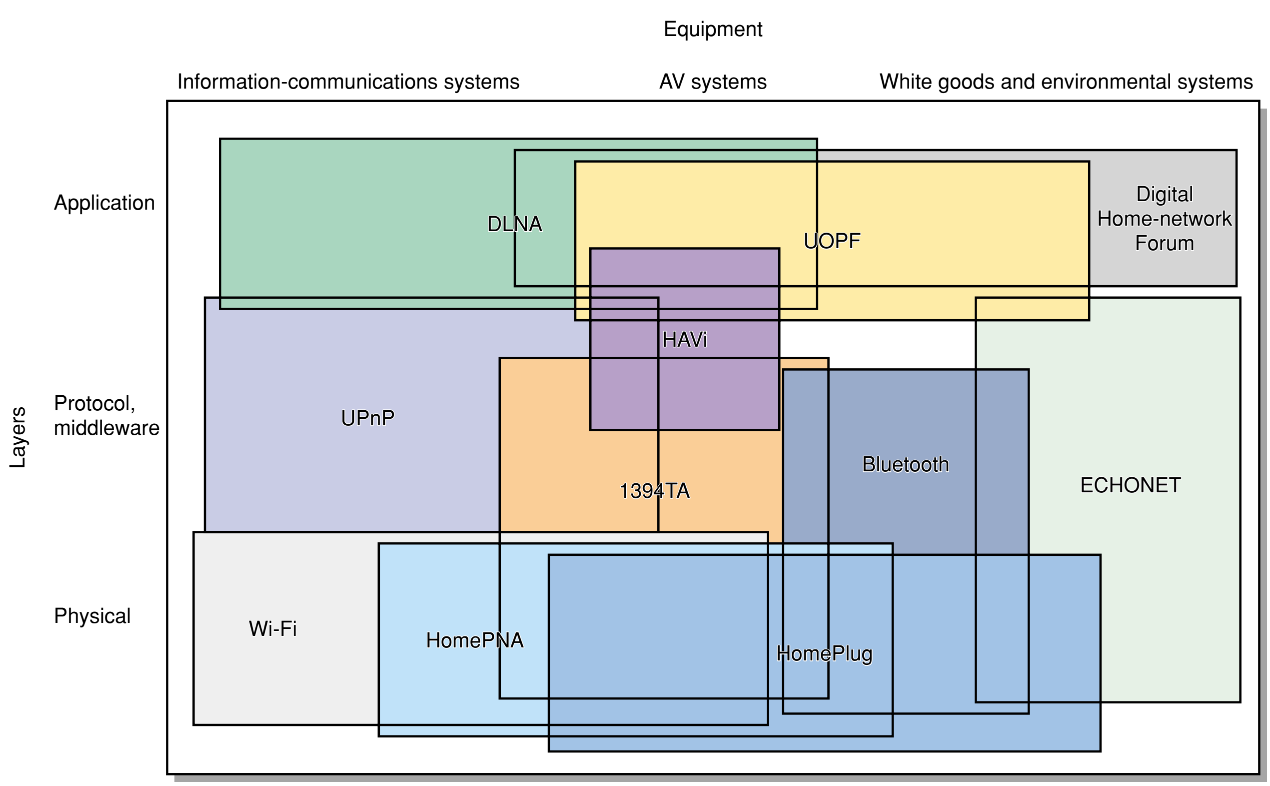

Fig. 1. Positions of standards organizations.

defines that the service platform shall be installed on a Java virtual machine (JVM) implemented on hardware and operating systems, and various distributed program modules can be either added or deleted as required by Java while the system operates as normal (**Fig. 2**). The framework of this platform is implemented in such a way that basic functions needed for the system, functions dealing with security and similar services, and basic functions required for network connectivity are already standardized in the form of "standard functions" or "recommended services". New services can then be added or the overall framework can be extended or modified by adding or deleting service program modules. In the context of OSGi, these program modules are referred to as bundles.

2.2 Improving equipment quality and operability

In the past, the emphasis on improving the quality and operability of equipment has tended to focus on the distribution of video and music. Video distribution is based on the assumption that faster optical networks will be implemented in the future, so systems that will support high-speed streaming distribution up to and including HDTV video signals are being considered. HDTV is carried by 25-Mbit/s IP packets, so efforts are focused on supporting that throughput without any loss of data. At the same time, progress is being made on the interconnectivity standard HSAC-RTSP that has emerged as a *de facto* server-client distribution protocol for implementing video distribution services (HSAC: Hikari Service Architecture Consortium, RTSP: realtime streaming protocol).

Meanwhile, with the goal of implementing user-friendly services for distributing music, good progress is being made in operability for consumer electronic, light processing load browsers, menu-descriptive language configurations, and so on.

3. Future initiatives

As we are seeing increasing activity based on the assumption of ubiquitous information networks, a survey was conducted to ascertain the misgivings and concerns of ordinary people in using ubiquitous services. People were apprehensive about security and safeguarding their individual privacy. Moreover, many respondents expressed apprehension about increasingly complicated system operation. Since all kinds of equipment will be connected to the network in future to implement an environment that seamlessly integrates this equipment and provides services, the problems of security and operability will certainly increase as time goes on. Here, I consider some

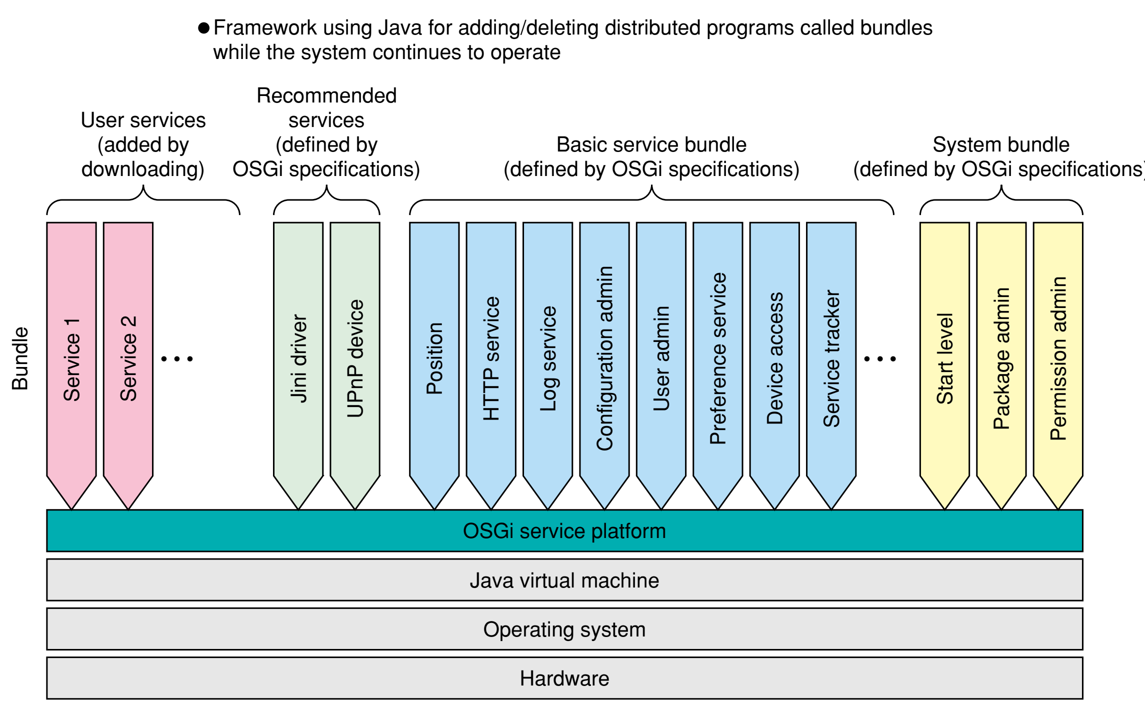

Fig. 2. OSGi service platform.

technologies that will be developed in this area in the years ahead.

3.1 R&D approach to home networks

OSGi will further evolve into an adaptive middleware platform promoting the use of technologies that will provide (1) advanced services by integrating devices, (2) effective utilization of resources, and (3) safe and secure services. More specifically, all sorts of diverse services will be achieved by combining devices for aggregate communications and information; e-commerce, settlement, and reservations; remote management and control; home security; home control; and entertainment.

Consider home security as one example. By combining different sensor and communications devices, we could develop a service in which a sensor detects a problem or abnormality and reports it. There is expected to be considerable demand for just such a service in the future. In particular, services that alleviate the problems of the aging society are expected in the field of home security. In addition, services corresponding to the conservation of energy and environmental problems that eliminate unnecessary power consumption in the house are expected in the field of home control, and they will play key roles in society.

One concept being proposed that would support these capabilities is a service aggregation platform that further extends the functional capabilities of OSGi (**Fig. 3**). The scheme would manage bundles (program modules) on the server side, deliver bundles to home service gateways (the functional unit) deployed in homes and offices, and support advanced services through seamless integration of various kinds of devices. The most unconventional and unique aspect of the scheme is that multiple service providers would use the same device installed in the home. This would permit more effective utilization of device and would not only hold down the costs for separate services but would also help stem the flood of new equipment and devices since it relies on a single gateway device.

Moreover, security issues relating to the use of bundles have emerged as a paramount concern. The major issues are authenticating the interconnection between server and client to ensure that the source of the bundle is a legitimate server and verifying the downloaded bundles to ensure they are legitimate. One scheme that has been proposed to address these security concerns is Communication Service Concierge (CSC) [1], which would extend the security functions of the OSGi service platform by verifying interconnections between servers and clients, providing encryption, verifying bundles, and controlling access during execution.

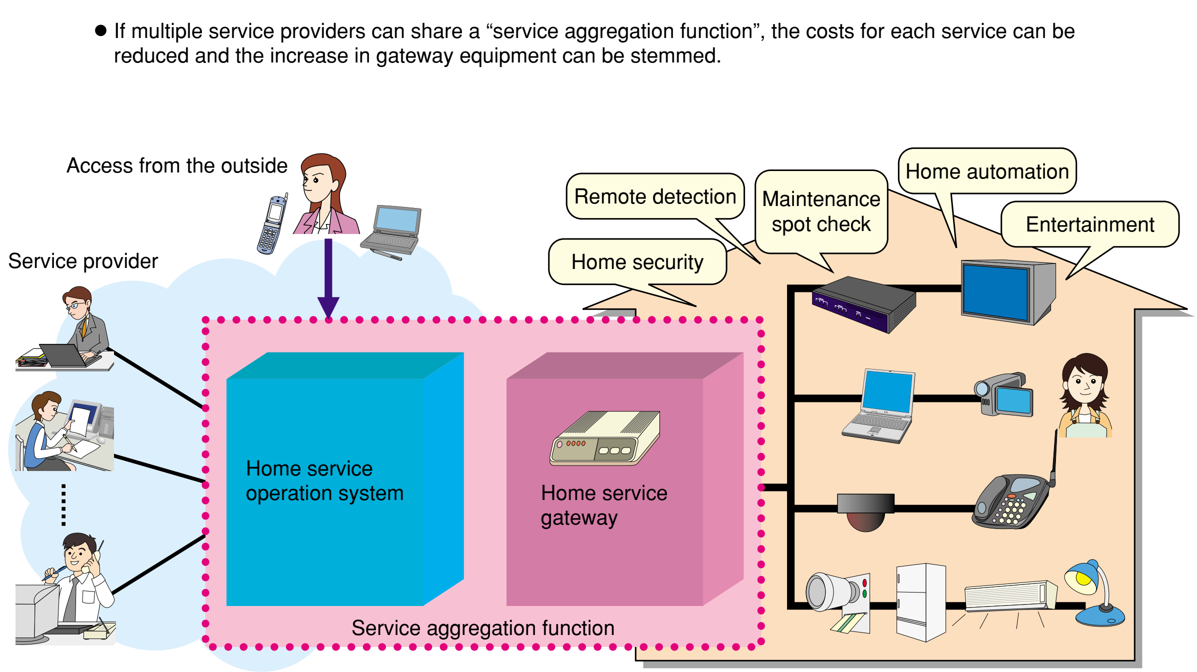

Fig. 3. Service aggregation.

3.2 R&D approach to networked appliances

Turning to networked appliances, the primary issue is how they can be made easier to use. Development of a user-friendly interface technology that eliminates barriers to easy operation is critical. Here, I will highlight three aspects of the issue: (1) Secure intuitive operability, (2) operation support and proxy operation, and (3) diverse display, notification, and operability.

(1) Secure intuitive operability

IC tags have attracted considerable interest as a way of implementing more intuitive easy-to-understand interfaces. For instance, a system that connects an IC tag with the network, reads it with a terminal, and achieves easy access to necessary information has been examined. In such an operation, the IC tag will specify the connection to the service and access to various types of information will be achieved easily. Work is now underway on a scheme that will extend this concept so that various networked appliances can use it. The key issues are how to implement a trigger for using services that is easy to use and how to develop a worry-free scheme that eliminates the potential problems of unwanted services imposing on you or your services imposing on others who do not want them.

(2) Operation support and proxy operation

It should be possible for a remote support center to instruct someone such as a novice or an elderly person who is having trouble and for a designated alternate person to operate a terminal remotely for someone who cannot operate it by himself or herself such as a grandchild operating it for a grandparent. Some work has been done in this area already such as the development of the remote desktop, but we need a new operating support scheme that supports interoperability between different hardware environments.

(3) Diverse display, notification, and operability

In a ubiquitous information environment, different types of terminals and networks are often used in different locations. This requires technology that brings together peoples' activities and environments so that they are free to receive services from whatever equipment is available at a particular location with the assurance that it will work properly. In other words, what is needed is a multimodal interface that effectively absorbs the differences between people, services, and equipment. For example, one solution would be a system that takes the same basic content and adapts it to whatever equipment is available locally so the content can be delivered as video or still images if imaging capabilities are available, as speech if audio capabilities are available, or as email if only email capabilities are available in the environment.

4. Overview of the R&D Forum demonstrations

This section briefly describes the demonstrations given at the Forum.

4.1 Home network demonstration

A service linking a number of devices was demonstrated under the title "Safety Home Demo" (**Fig. 4**). A home service gateway unit was installed in John's home along with various kinds of network-connected device such as power meters, lighting equipment, temperature sensors, displays, telephones, and motor-driven curtains. In one scene, a visitor came to the front door and pressed the intercom button. John failed to notice because the buzzer was drowned out by the TV. The home service gateway realized that someone was pressing the intercom button and used various resources to determine John's location in the house. Once the system determined that he was watching TV in the living room, it superimposed a picture of the visitor in one corner of the TV screen. The system could also have been set to automatically lower the volume on the TV at the same time.

Temperature sensors let the home service gateway recognize when a fire broke out in the house and sound a warning over the networked TV set (or telephone) via a notification service. Another service, linking a light sensitive sensor and a device for opening and closing curtains, automatically opened the curtains when it was light outside and closed them when it was dark.

These and many other services will be made possible by introducing the service aggregation platform technology now under development. While the system is up and running, it can accept additional devices, devices can be combined to make new services, and required bundles can be downloaded from the server as needed.

4.2 Appliance demonstration

(1) Broadband appliances

A number of advanced capabilities were demonstrated including simple operation, operation by proxy, and remote operation (**Fig. 5**). A personal terminal was shown being used as a remote controller for several different devices in the house, as an information terminal outside the office and on a business trip, and as a remote controller for taking over control of another terminal in a remote location where an

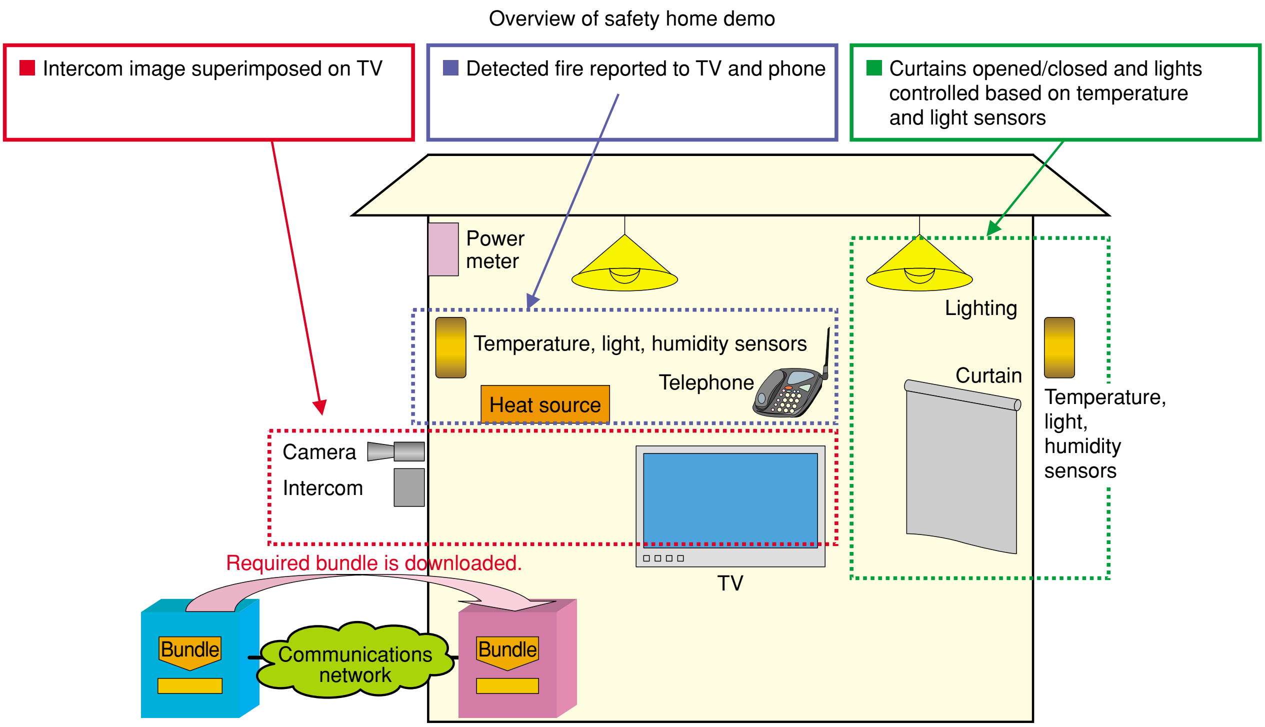

Fig. 4. Demonstration at the Forum (1).

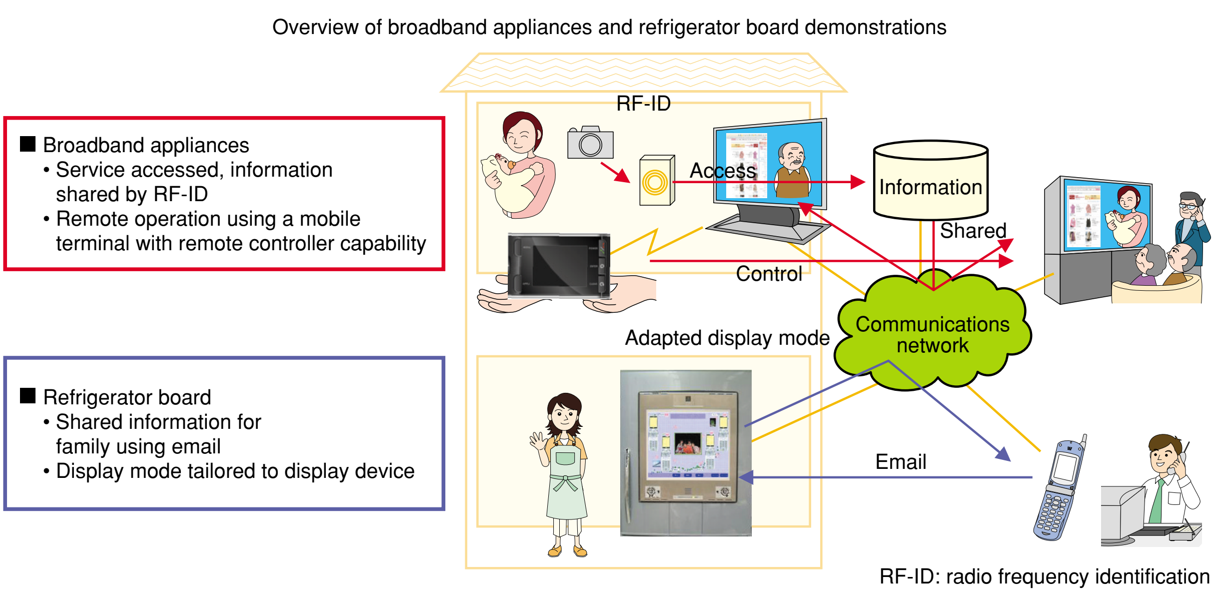

Fig. 5. Demonstration at the Forum (2).

elderly person was experiencing trouble. In other words, the system permitted a full range of operations on the terminal in front of the user or on a remote terminal on a network.

(2) Refrigerator board

Since many families stick messages, memos, and schedules up on their refrigerators as a convenient central spot for sharing common family information, a digital memo (refrigerator board) could be just as effective, but it must be implemented in such a way that the same information can be shared on a number of different devices with different display characteristics. In the demonstration at the forum, a multimodal interface permitted John to access the refrigerator board from a cell phone outside the house and from a PC or personal terminal inside the house. The system automatically converted the format and content of the same message to match the display capabilities of the various networked devices.

Reference

[1] http://www.ntt.co.jp/news/news02e/0202/020227.html

Profile

■ Career highlights

He received the B.E. and M.E. degrees in electrical and electronics engineering from Kobe University, Kobe, Hyogo in 1982 and 1984, respectively. He received the D.E. degree in electrical engineering from the University of Tokyo, Tokyo in 1996. In 1984, he joined the Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corporation (now NTT), Kanagawa, Japan, where he has been engaged in R&D of still image and video coding, video communication systems, networked appliances. He is now a Senior Research Engineer, Planning section at NTT Cyber Space Laboratories. He is a member of the Institute of Electronics, Information and Communication Engineers of Japan, the Institute of Image Information and Television Engineers, and the Institute of Image Electronics Engineers of Japan.