Place-based Services Platform Quickly Establishing Connectivity Services between Smart Devices and Equipment at Purpose-specific Places

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Recent years have seen the increasing adoption of smart devices in places where people gather for specific purposes, such as stores and schools. Hitherto, the realization of services to link people's smart devices to others' smart devices or equipment at a given place required a multitude of prior set-up processes for users, on the one hand, and complicated programming for application developers, on the other. Thus, Fujitsu Laboratories has developed platform technology for place-based services, enabling connectivity services to be established quickly, linking people's smart devices to others' smart devices or equipment at a given place without a need for member registration or driver installation. The technology may achieve a reduction of up to 90% in the time required for developing application programs to enhance the connectivity at places where people gather for particular purposes. Potential applications of this technology include facilitating group study in a school, providing product information to a customer's smart device in a store, or introducing merchandise by linking devices to a big screen display. This paper explains the component technologies for the place-based services platform and its applications, drawing on some actual cases.

1. Introduction

It is estimated that 50 billion devices will be connected to the Internet in 2020. The Internet of Things (IoT) is expected to enable users to connect their smart devices to the network and remotely control other equipment, to gather data from peripheral devices and analyze them in the business and day-to-day contexts for practical use.

Fujitsu Laboratories is working to realize a hyper-connected cloud (**Figure 1**) that is designed to support various tasks in people's work and daily lives through connecting their ICT devices to their surrounding devices and the Web services. The connectivity technology for smart devices, bridging between people and surrounding devices, needs to be further developed to achieve this end.

Smart devices such as smartphones and tablets are used at stores, schools, hospitals and in other situations today. So far, Fujitsu Laboratories has been pursuing the development of a services platform, offering the context-switch technology[4),5)] that securely distributes appropriate mobile applications to users depending on their situations.[1)–4)] It can easily turn their devices into a work-dedicated terminal, thereby enhancing their work efficiency.

A context-switch is technology to identify a given smart device's location based on the data detected by the smart device (e.g., GPS locational data, Wi-Fi access point service set identifier (SSID), near field communication (NFC) tags and/or QR codes attached to specific places, accelerometer outputs), and it distributes the applications associated with the detected location. The application distribution can be based not only on geographical locations, but also on logical conditions detected by software sensors, such as changes in Web content or push notifications. In this paper, a "place" refers to such geographical locations and logical conditions together with applications associated with them.

2. Challenges

Smart devices are being adopted increasingly widely in stores, schools and other places where people gather. In stores, for example—sales clerks use a screen display installed in store to explain their products to customers. In schools, teachers use smart devices to distribute learning materials to students, and to share

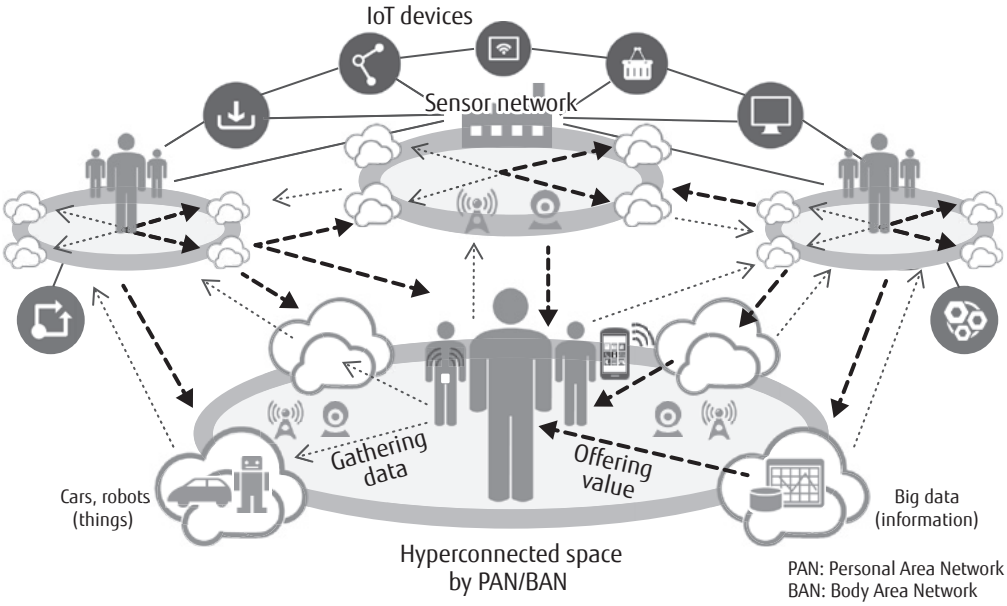

Figure 1
Human-centric hyperconnected cloud.

screen images among students in group studies. In hospital, a patient is asked about his/her symptoms based on an answer to an interview medical sheet. These Q&A data are inputted to on-site smart devices. Here, there is a need for a system to share the data between on-site smart devices. The technology will help information to flow in the field, and further enhance the work efficiency by making it possible for users to leverage the shared information.

In order to make this a reality, however, there are the following issues to be overcome:

1) Difficulties in exchanging information between nearby users

In order to exchange information between given devices, users have to undergo complex procedures of logging into the system with their user IDs and passwords, specifying recipients, and so on.

2) Difficulties in connecting user devices with on-site equipment

The devices people carry with them need to have appropriate drivers installed to connect to local equipment in the location, and users may need to detect and specify the equipment.

3) Labor-intensive service development

Preparing place-based connectivity services involves many tasks, including the development of dedicated applications, a server system equipped with features to connect devices with other devices or equipment, and libraries to facilitate the access to the server system via the applications.

3. Developed technology

In addressing these challenges, we have developed the following three types of technology, and integrated them into a place-based services platform[6] together with the local application store that distributes applications to smart devices (**Figure 2**).

1) Device-to-device connectivity through a place

Figure 3 illustrates the device-to-device connectivity technology. First, a smart device detects local points such as Wi-Fi access points or NFC tags, and checks in to a corresponding place [1) in Figure 3]. Then, the server automatically sends out the application with the connectivity feature to other devices, together with an authentication ticket to validate the check-in to this place [2) in Figure 3]. The application uses the ticket for authentication against the server, and in this way the device can exchange information with other devices that hold identical tickets [3) in Figure 3].

In this case, the context-switch technology facilitates the data exchange between devices that have checked in on the same place, without them having to log in to the system with unique IDs and passwords.

2) Virtualization of equipment

A virtual driver is provided as a Web application programming interface (API), which abstracts the basic functions of the I/O devices in the place (e.g., displays and pointing devices).

The virtual driver converts equipment-specific interfaces into Web APIs based on the abstraction rules, which are defined for each piece of equipment, thereby cancelling the discrepancies between devices. The application installed on the smart device calls the abstraction Web API via a service API, and controls the equipment. With this system, there is no need to install drivers on the devices, and simply checking in to the place will give the user access to the equipment instantly (**Figure 4**).

3) Local Web service

Necessary common features such as communication between applications and control over shared memory are provided as local Web service APIs to facilitate data exchange between devices as well as with equipment in the same place (**Figure 5**).

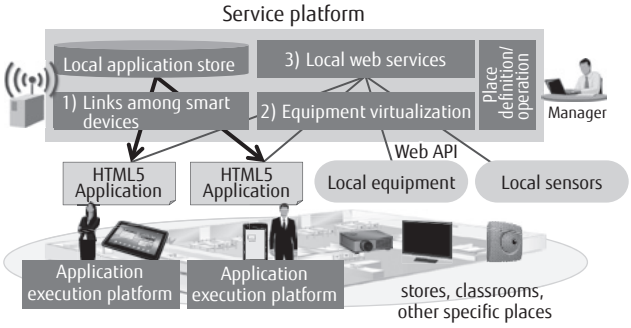

Figure 2
The newly developed service platform.

4. Expected benefits

This place-based services platform makes it easy for smart devices to exchange information with other devices in the same place without the need to perform complicated configurations, as long as the users install an application execution platform. This connectivity without the need for installing drivers also helps to enhance the work efficiency on-site. For developers of mobile applications, there is a great advantage because the local Web service that offers various common features is readily accessible via service APIs. This means that there is no need to develop Web services or the libraries to use such services, saving a large number of person-hours in application development, reducing them down to one-tenth in some cases. It is possible to apply the connectivity feature for data exchange between devices or between a device and piece of its surrounding equipment, for instance, in the situation of group studies at school, and, in stores, sending product information to customers' smart devices or connecting to a large-screen display on which product information is projected.

5. Application examples

In this section, we describe the place-based services platform in terms of its applied uses.

1) Education

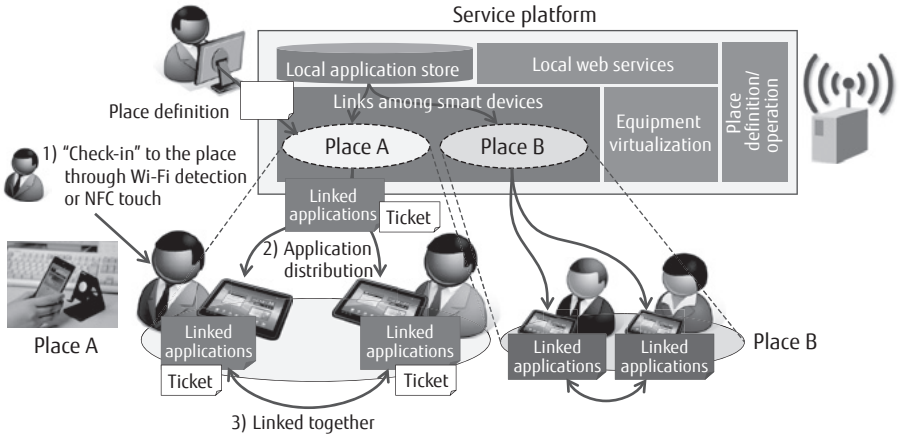

Figure 3
Technology for linking smart devices.

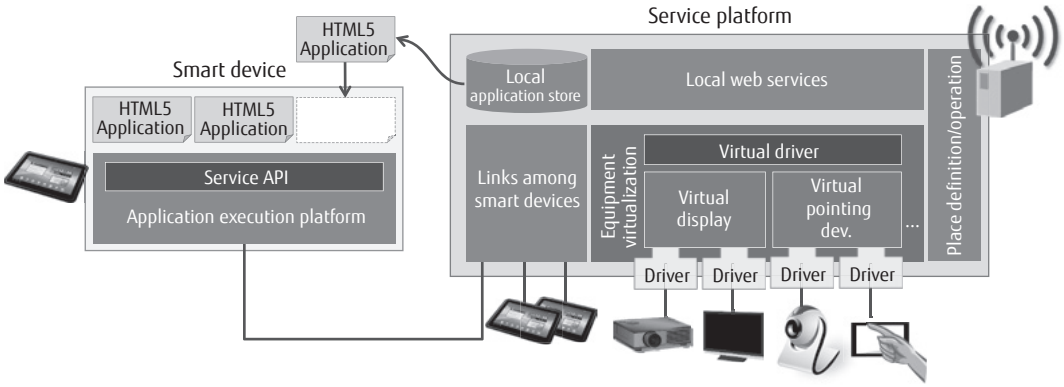

Figure 4
Equipment virtualization.

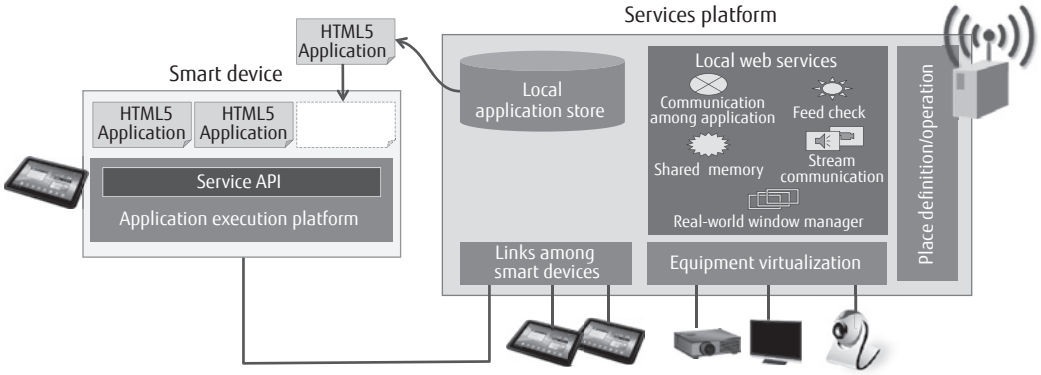

Figure 5
Local web services.

We conducted a pilot demonstration of this platform used in a classroom, jointly with Konan University.[7] This pilot test was designed to automatically connect tablets and other smart devices carried by teachers and students, as well as on-site equipment such as projectors. We constructed a system through this technology that executes automatic simultaneous distribution/deletion of lecture materials, as well as other services assisting collaborative group studies, learning progress monitoring and projection of performance results onto a large screen (**Figure 6**). Group discussions, for example, used to be carried out using large pieces of blank paper, post-it notes and whiteboards. A screen sharing application can replace the paper, and students can engage in debate using tablets for the same function. Furthermore, teachers can easily review each group's progress on the tablets at hand. By leveraging this platform, it enabled effective learning in group studies

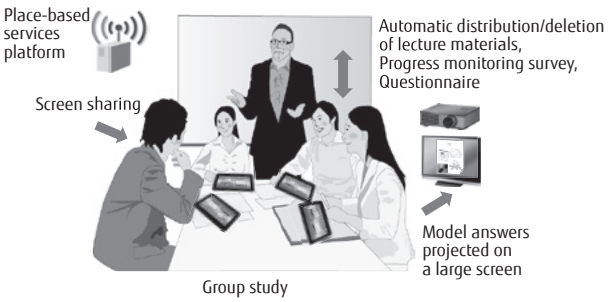

Figure 6
Application example: education sites.

to encourage active participation by all group members and to develop arguments, to draw out diverse opinions, and to stimulate class dynamics.

2) Front-line medical care

This platform can be applied in the place of medical care, such as doctor's home-visits and nursing care

delivered by social workers. Doctors and care-nurses bring tablets with them when visiting patients. The tablets identify the location, and automatically connect to the server. Then, based on the locational data, the patient is identified and relevant information is sent to the tablets to be displayed instantaneously. It can also improve work efficiency in the field through enhancing the connectivity to medical equipment on site, and automatically delete personal data and medical records from the device when the user leaves the location.

3) In stores

Applying this platform in stores, banks and other commercial premises, it can facilitate automatic distribution of, say, promotional vouchers or product information tailored to individual customers. It can also coordinate easy connection between a store assistant's smart device, storefront digital signage displays and customers' own devices, helping assistants to more effectively attend to customers.

6. Conclusion

This paper presented the place-based services platform and its application scenarios. Fujitsu Laboratories has developed the platform, with the ultimate goal of realizing the hyperconnected cloud in mind. The platform makes it possible to quickly build connectivity services to bridge between humans and devices. This technology will bring benefits of the connectivity services to smart device users simply by installing the platform to run mobile applications. No advance registration or driver installation is required, and at the same time, work efficiency can be improved.

We will conduct further pilot tests on this platform technology at education, medical care, and retailing sites, and evaluate the value of this technology, enhance its functionality, and develop scene-specific templates and solutions, in preparation for practical applications.

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