Technology Requirements for Ubiquitous Environment and Fujitsu's Realtime Communicator Solution

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A broadband, low-cost communication infrastructure based on the Internet, hotspots, and wireless LAN environments is becoming a reality. Moreover, terminals such as cellular phones and Personal Digital Assistants (PDAs) are evolving very quickly. Against this background, a ubiquitous environment that can be accessed at anytime and anywhere through various kinds of terminals is being constructed. However, because of the fast pace of change, it costs service providers a lot of time and money to provide high-quality services to users, and new technological developments are needed to solve this problem. This paper describes the technology requirements for achieving a ubiquitous environment and a Fujitsu middleware product called Realtime Communicator that can meet them. Then, this paper describes two typical applications of this middleware.

1. Introduction

The ubiquitous environment is rapidly developing thanks to advances in terminal technology, the growing network environment, and the reorganization of services using Web service technologies[1),2)] such as Simple Object Access Protocol (SOAP)[3)] and Universal Description, Discovery and Integration (UDDI).[4)]

Individuals can use various terminals, media, and network environments and access several services in this ubiquitous environment. On the other hand, these services can actively provide information to users according to their presence information, for example, the status of their terminals. Users now want a ubiquitous environment in which they can smoothly use information in real time in both Business to Consumer (BtoC) and Consumer to Consumer (CtoC) interactions.

This paper describes the technology requirements for achieving a ubiquitous environment and a Fujitsu middleware product called Realtime Communicator that can meet them. Then, this paper describes two typical applications of this middleware.

2. Technology requirements for a ubiquitous environment

The broadband, low-cost mobile communication infrastructure has grown in response to the spread of a wide range of electrical equipment. The list includes cellular phones, Personal Digital Assistants (PDAs), on-board car information equipment, intelligent electrical appliances, fixed-charge Personal Handy-phone System (PHS), third-generation cellular phones, wireless hot spots, and LANs. As a result, a ubiquitous environment that enables users to access services over the Internet anytime and anywhere has become a reality. Now, it is important to develop middleware that enables easy interactivity between users and services, whatever the users' environment and status.

In the ubiquitous environment, users access the Internet in various places with various com-

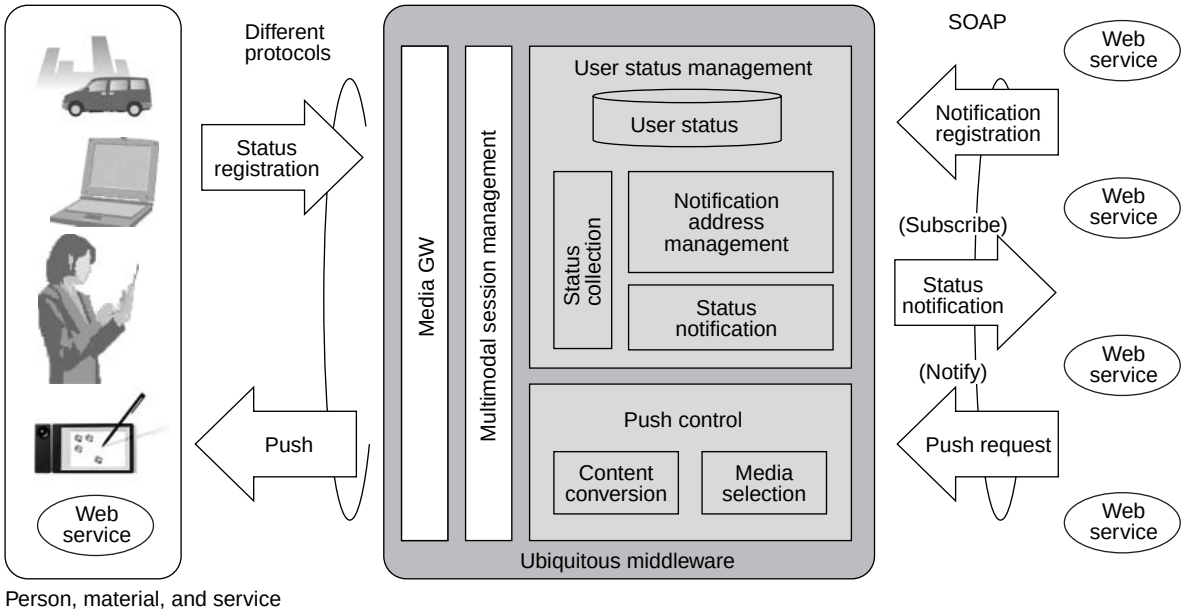

Figure 1
Ubiquitous middleware.

munication media and terminals. Therefore, services should provide contents that are personalized to suit the location, the capabilities of the communication terminal, and the users' status. Moreover, because users cannot always be aware of changes occurring at the service side, services should be pushed autonomously according to the users' status.

To achieve the above, services must know the users' status in real time. For example, they must know which communication media and terminals users are using or have access to, whether that equipment is busy or free, and location information. Therefore, a mechanism that notifies services whenever equipment undergoes a specified status change is required. Such a mechanism would make it possible to reduce unnecessary communication costs and provide high-quality communication services.

Also, when services offer contents according to the users' status, it is necessary to offer the most appropriate content for the communication media and terminals being used. For instance, consider the case in which restaurant information is provided through a car navigation system. The restaurant's location is displayed on the terminal's screen. However, because the driver cannot look at the screen until the car has stopped, the system automatically switches to voice guidance. In addition, when the driver stops the engine and leaves the car, the service continues to send information to the driver's cell phone in the form of email. This requires a mechanism that makes it unnecessary for the service side to consider the communication media and terminal; otherwise, the extra processing that the service application program needs to perform will cause a cost increase.

3. Realtime Communicator ubiquitous middleware

Fujitsu uses the term "ubiquitous middleware" to describe a framework that provides these two mechanisms and easily realizes interactions between users and Web services in the ubiquitous environment. We have developed a ubiquitous middleware called Realtime Communicator.

This middleware is composed of four modules (**Figure 1**).

1) Media Gateway (GW)

This module compensates for differences be-

tween different types of communication media and abstracts the users' status. It also sends a push request to each communication media.

2) User status management

This module contains sub-modules that collect information about the users' status, manage the notification destinations and the conditions for reporting the users' status, and reports the status. The users' status are managed using XML forms, which are used for notification reservation in accordance with Xpath.[5] The status are managed by a relational database, and a large number of them can be retrieved and updated at high-speed.

3) Push control

This module receives push requests from a service. It then selects a media and converts the contents according to the users' status.

This module, for instance, distributes high-quality content to a user's PC in an office and converts the content to a reduced HTML form for use on the user's cell phone outside the office.

4) Multimodal session management

To keep a service's contents consistent when two or more modalities, for instance, Web and voice, are combined and one service is provided, this module manages these sessions as a single session. Therefore, the Web service does not directly need to consider the type or status of the terminal being used, and the best service can be offered using multiple modalities by cooperating with a media GW.

Web Services receive user-status update notifications from the user status management and provide services according to the status by registering the notification condition in the user status management. Therefore, not only simple conditions but also complex combinations of multiple conditions can be specified as a notification condition. Moreover, when a service is provided to a user in response to a change in the user's status, this module sends a contents delivery request to the push control. The push control automatically distinguishes the user's terminal type and converts the original contents into a form appropriate for the terminal. As a result, the service is provided to the user without needing to consider the type of terminal being used.

Some examples of how these functions can be used are described below.

1) Area information push

Notification reservation is done when a user is near a store, and sales information is pushed to the users whose conditions it matches. For instance, information about an experimental service can be sent to a user's cell phone when the user uses a commuter pass at an automatic ticket gate in a train station.

2) Seamless navigation

Navigation information is pushed to an on-board terminal during a trip and then pushed to portable equipment when the driver leaves the car.

3) Offering multimodal contents

Contents are converted to voice, images, text, or combined multimodal contents according to the terminal's capabilities. For instance, in a Web-based consumer customer support system, answers are automatically switched to short texts for inquiries from a cell phone. On the other hand, images and/or voice are added for inquiries from a PC.

4. Application to real systems

Next, we describe two typical applications of the ubiquitous middleware we have developed.

4.1 Sales force strengthening and cost reduction by knowledge sharing

The first application is for a company that makes and sells cosmetics (**Figure 2**).

The company employs more than 7000 salespersons nationwide in addition to its regular employees. The salespersons need to be promptly notified on-site about new sales policies and any other relevant, new information from the headquarters. Therefore, the company has decided to give a PDA to each salesperson so it can transmit this information.

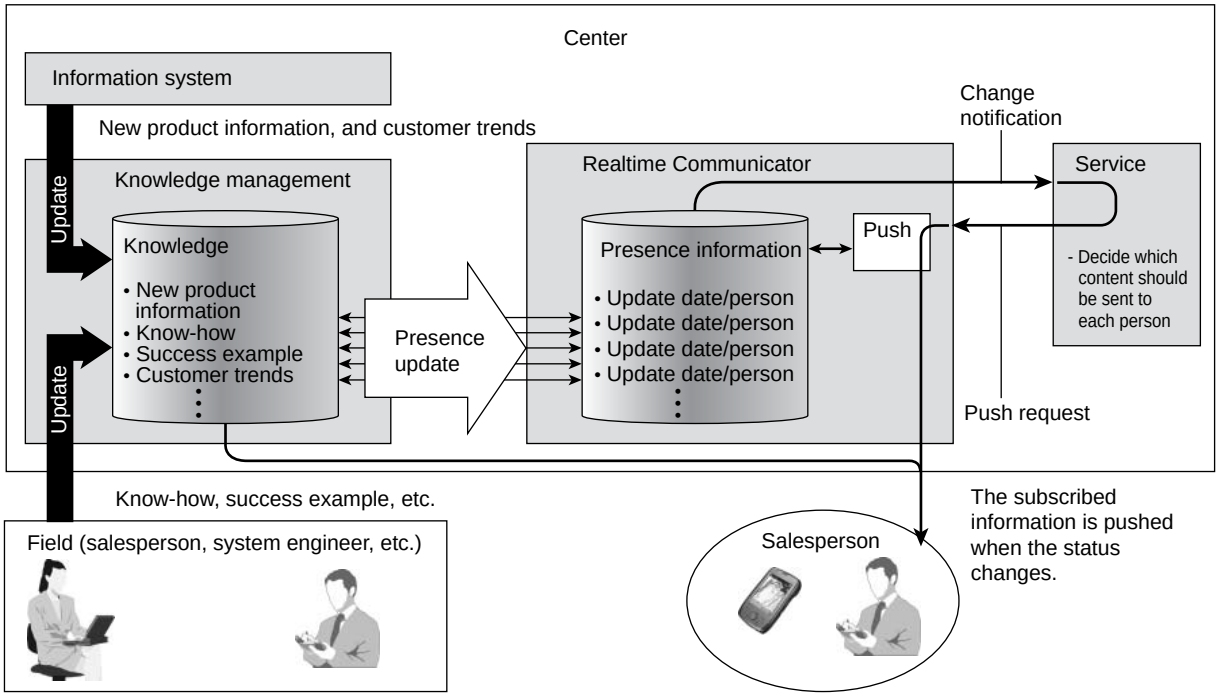

Figure 2
Knowledge sharing.

However, there is a wide range of salespersons, from beginners to seasoned employees. Therefore, it is unnecessary and also, in some cases, unwise (from a security point of view) to broadcast all information to the entire sales force. Moreover, the sales force can be greatly strengthened by teaching beginners the abundant know-how of experienced staff. Know-how has been accumulated in the form of, for example, documents, figures, and action records. Also, the know-how that is needed differs according to the salesperson's length of experience and the commodities being sold. Therefore, the information must be personalized according to the salesperson's role and level of responsibility.

The user status management of ubiquitous middleware manages the PDA owners' attribute information. As a result, the system can find out the salespersons' length of experience and level of responsibility. Based on this information, the system can transfer the appropriate information to each salesperson by personalizing the sales policy and the new release information.

4.2 Development of new services by status watch and remote maintenance of appliances

The second application is for a company that makes and sells consumer electronics (**Figure 3**).

Nowadays, most homes have many home appliances and the price and performance of these appliances are generally the same whichever company manufactured them. To get new customers, therefore, it is necessary to add value to appliances and improve customer satisfaction. Thanks to recent advances in high-performance consumer electronics, networks can now be constructed in the home and the status of home appliances can be monitored. This makes it possible to provide preventative maintenance services.

In this application, a home server can be installed in a home and the status of each appliance in the home can be monitored. The home server reports a status change to the ubiquitous middleware at the service center when an abnormality that indicates a future breakdown is detected. The user status management manages attribute in-

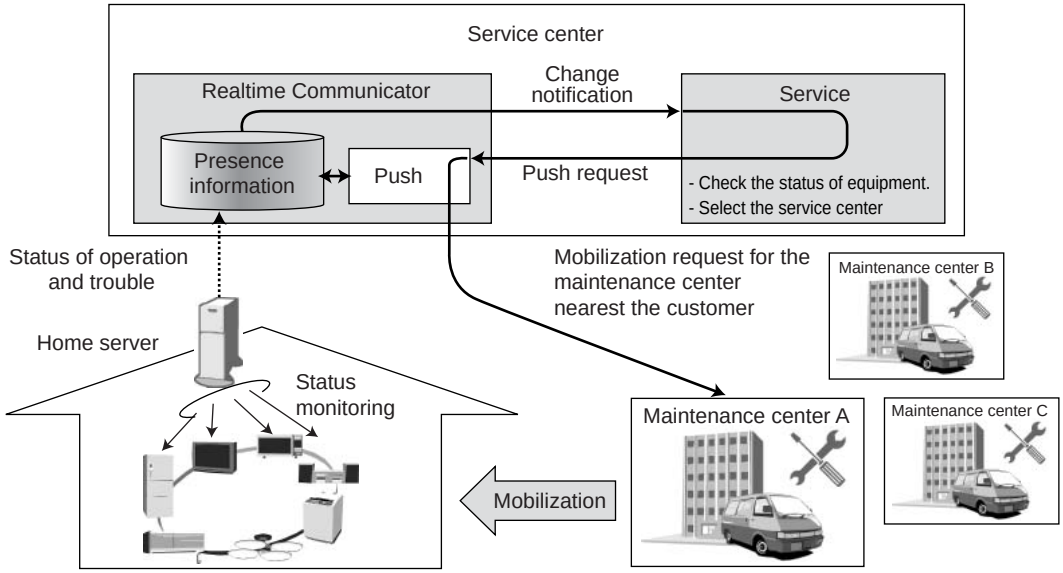

Figure 3
Remote maintenance.

formation about home appliances in homes according to the details in the service contract. The user status management that receives a report notifies the service application program, which then determines whether repair is necessary by referencing attribute information about the appliance. When repair is determined to be necessary, push delivery requests the nearest maintenance center to make the repair. Then, the maintenance center that receives the request repairs the home appliance after contacting the customer. Through these processes, it becomes possible to prevent products from breaking down and provide timely customer services.

5. Conclusion

This paper described the technology requirements for achieving a ubiquitous environment and a Fujitsu middleware product called Realtime Communicator that can meet them. Then, this paper described two typical applications of this middleware.

Information and services on networks will continue to increase in the future, and more and more people will be accessing these resources. In the future, middleware for constructing ubiquitous systems will become more important. We plan to continue our research and development and look ahead to anticipate the movements of the continually evolving network society.

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