Context Sharing Platform

By Katsumi NIHEI*

ABSTRACT When a ubiquitous society is realized, various types of sensors will be ubiquitous in the real world. The sensors will enable us to obtain information concerning the state of people, objects and environment (context). The importance of "context-aware services" that provide services to users according to their context information is increasing. By sharing context obtained by sensors set up by various types business, a new service that utilizes context information can be created. NEC is conducting research and development of context sharing technology to enable various types of businesses to share context. A context sharing platform is a system that incorporates context sharing technology.

KEYWORDS **Ubiquitous, Context, Context-aware, Sharing**

1. INTRODUCTION

When a ubiquitous society is realized, users will be able to connect to networks under various circumstances at any time, anywhere, and will be able to enjoy services through their computers. Various types of sensors will therefore become ubiquitous in the real world, and users will be able to connect with networks to obtain information concerning the state of people, objects and environment (context). Beginning with network control for changing the server access route according to the user's context information, it is thought that the importance of context-aware services that provide services to users according to their context information will increase.

Up to now, each business has set up its own sensors to get context information. Services using user's context information were provided but the context information was available only to that business. As long as the service is limited, there is no problem with businesses setting up their own sensors. A traverse service that uses various types of user's context information is demanded for the future, but with the current methods available, it is not realistic from the aspect of cost. The point in ubiquitous society is sharing context information from sensors set up by various businesses.

NEC is therefore conducting research and development of context sharing technology so various businesses can share context information. A context sharing platform is a system that implements context

sharing technology. With a context sharing platform, a service that could for instance find out how much traffic is going through turnstiles at the nearest station to calculate how long it will take you to get home, so you it turn your air conditioner on and have the room cooled to a comfortable temperature by the time you get home could be possible (see **Fig. 1**).

2. CONTEXT INFORMATION AND CONTEXT-AWARE SERVICES

2.1 Context Information

There is no uniform definition for context information. There is context information sorted into categories[1,2] and context information defined according to the way it is used or obtained[1,3]. The approximate consensus is "information concerning the state of people, objects and environments, and is primarily obtained automatically." Examples of context information include people's position, profile, tastes, biological information, engine temperature, monitor resolution, software processing speed, and local climate and temperature.

For the purpose of our research and development, context information is defined as "information concerning the state of people, objects and environment." The context information applicable to the research is limited to context information obtained from information sources providing services on networks, not context information obtained on a real world.

2.2 Context-Aware Services

The context information obtained is used for providing services to users or systems according to the context. Such services are called as "context-aware

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services." **Figure 2** shows a context-aware service model. Context information about people, objects and environment is obtained by sensors such as RFID and GPS, and then send to a context information management module. With the context information management module, the format of the context information generally differs from sensor to sensor, and the frequency with which it occur differs, the sensor is concealed from applications and the application is notified of the context information. Applications provide service to actuators according to the context. If the information concerns people for example, the actuator acts as a display and a speaker.

3. DEVELOPMENT STEPS OF CONTEXT SHARING

Context sharing is developed in the following steps (**Fig. 3**).

1) Model where context sharing is restricted to a single business
2) Model where context sharing is restricted to certain businesses
3) Model where context sharing is open to all types of businesses

1) Model where context sharing is restricted to a single business
The model where context sharing is restricted to a

single business is the first step model of context sharing. Businesses that set up sensors, businesses that manage context information, businesses that offer applications and provide services, and businesses that offer actuators are all united within a single business. The actuator may however by separate in some cases.

The form of context expression and notification protocol does not matter for the individual businesses themselves. Because context sharing is restricted to a single business, for example, context information provided by a user can only be used within that business, so it is OK if he has a contract with the business, and there is less problem with privacy. There is also less diversification of context information and sensors used.

2) Model where context sharing is restricted to certain businesses
The model where context sharing is restricted to certain businesses is the second step model of context sharing. Businesses that set up sensors and businesses that provide actuators are united within certain businesses. Context information management is typically farmed out to other businesses.

The form of context expression and manner of notification need to be uniform among the participating businesses. The context information of users is used by a number of businesses decided in advance, so it is necessary to consider privacy. Diversification of context information and sensors used is medium.
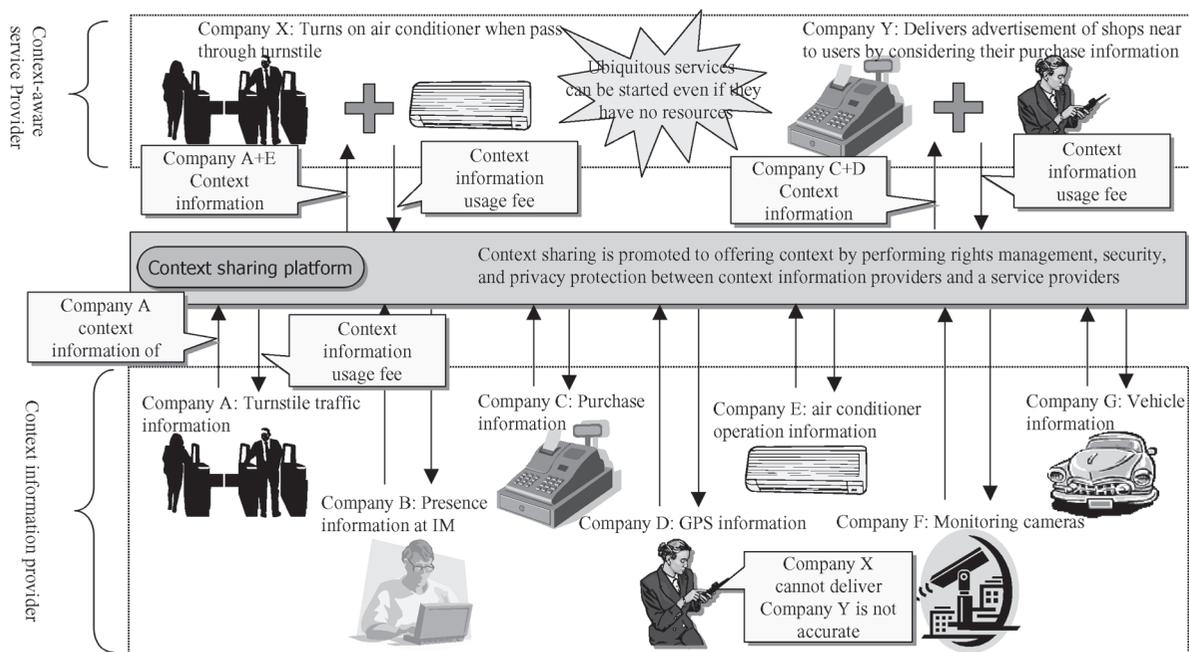

Fig. 1 Context information sharing.

3) Model where context sharing is open to all types of businesses

The model where context sharing is open to all types of businesses is the final step model of context sharing. Businesses that set up sensors, businesses that offer applications and provide services, and businesses that offer actuators all function as separate businesses and in some cases other businesses operate in the same layer, such as sensors. Context infor-

mation is managed by businesses that subcontract context sharing.

The form of context expression and notification protocol need to be uniform among the participating businesses. The context information of users is used by a number of businesses decided in advance, so it is necessary to consider privacy. Diversification of context information and sensors used is high and the scale would also probably be huge.

4. ISSUES

The following five issues concern context sharing.

1) Interconnectivity
2) Operability
3) Processing of context information
4) Largeness of scale and real time sharing
5) Rights management, privacy protection and authentication

1) Interconnectivity

In order for businesses to share context information, it is necessary for them to mutually know how the context information is expressed and by what protocol it is transmitted. It is not always necessary for context format and notification method to be uniform among businesses for restricted context-aware services, but with the context shared among businesses only, it is necessary to standardize context format and notification protocol to process intermediate languages for a gateway for example.
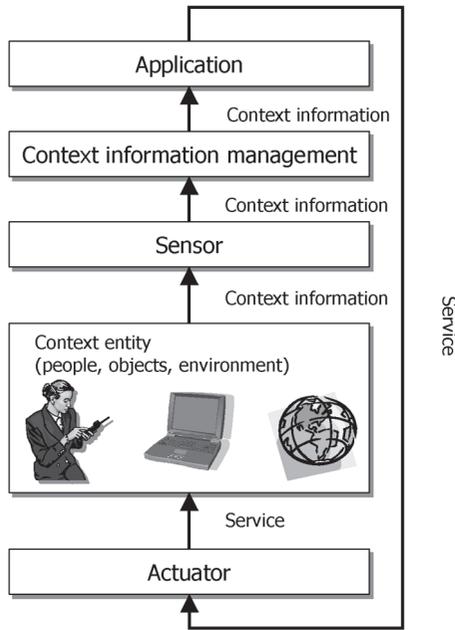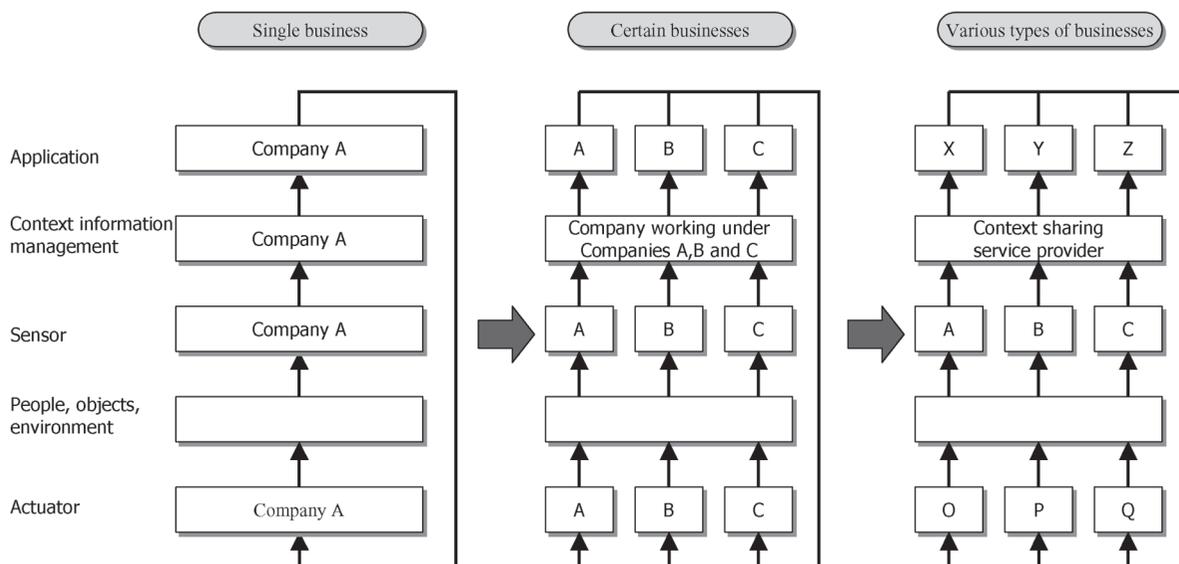

Fig. 2 Context-aware service model.

Fig. 3 Development steps of context sharing.

There is currently no standard context notation format. The main problem is there is a wide range of applicable context information and it is impossible to make a one size fits all notation format. A few attempts have been made at standardizing context notation format for a limited range of application. With Presence service, user status is given in PIDF (XML base presence language established by Presence Information Data Format IETF). What has however been standardized is the presence to express to the presence service whether the user in online or offline. All other presence is independently extended by the provider. The representative context, position, is often given in GML (Geography Markup Language: OGC). Attempts have also been made to give context in RDF (Resource Description Framework) (specification for metadata exchange on the Web written by W3C).

As for the context notification method, it is necessary to exchange context information in real time even when several terminals are connected by a network (depending on the type of context). Presence services use SIP (Session Initiation Protocol) to send notification of presence.

2) Operability

When a ubiquitous society is realized, large numbers of various types of sensors will be ubiquitous and will be able to connect to a network. In order to actually use them, it will be necessary for the sensors and terminals to be registered to a context sharing platform and technology to enable context request and notification will be necessary. With Universal Plug and Play (UpnP), a similar attempt, Jini automatically registers and connects PCs, telephones and electrical appliances to a network.

3) Processing of context information

If large numbers of various types of sensors become ubiquitous and can be connected by network, it will not be realistic for those requesting context information to specify context from a certain sensor. If the party making the request makes a high order request to a server such as "context information about Mr. Tanaka," it will require the server to have the technology to obtain, produce and notify context information from all sorts of sensors to satisfy the request. It will in particular be necessary to obtain and produce requested context information from sensors that are not directly related with the target context using ubiquitous sensors in the environment.

4) Largeness of scale and real time sharing

In a ubiquitous society, there would probably be massive context request and notification traffic where large numbers of terminals are connected by network. Massive quantities of all sorts of context information would need to be processed and passed on at high speed.

5) Rights management, privacy protection and authentication

Rights management, privacy protection and authentication are needed in order for businesses to share context information.

Access control and redistribution control are indispensable for realizing privacy protection and rights management of context information. Access control controls who is to have access to information; it also controls modification of contents such as diluted accuracy or partial deletion by the one of the parties sharing the information. Redistribution control controls to what point context provided to another party may be passed on to a third party or parties and how long it may be used. It also traces where context information is used and may control destruction of traced context information. Those two functions are needed for businesses to sell context information to each other.

Concerning privacy protection, if context information is restricted to within a single business, privacy is protected as long as the user has a contract with the business concerning handling of privacy. If context information is shared by businesses, however, it is necessary to specify to what extent the information may be disclosed and must be provided with a means to trace and destroy the information if necessary. Context information often includes extremely private information such as when and where a user has been. For use of context-aware services to spread, the user's privacy must be protected so that the users do not have to worry about their private information being leaked.

Authentication of context information is a technology for checking whether context information is authentic or not. If false information is sent from a phony terminal, it is detected to be false by authentication to prevent wrongful action.

5. CONCLUSION

This paper has provided a description of context information, context-aware services, steps of context sharing, problems involved with context sharing and service image. Sharing of context information by

businesses using a context sharing platform enables the creation of new context-aware services. In the future, NEC plans to continue research and development of context sharing platforms to solve these problems.

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