2005－UBI－8（35）
2005／6／9

Proposal of Ambient Communication using Context Awareness Technology

Kazunari TAKAHASHI　Daisuke YAMADA　Tadaaki ARIMURA　Tatsuya NAKAMURA
and　Shigetoshi YOKOYAMA
R&D Headquarters, NTTDATA Corporation
21-2, Shinkawa 1-chome, Chuo-ku, Tokyo, 104-0033, Japan
E-mail:　{takahashikzb, yamadad, arimurat, nakamurattc, yokoyamasgt}@nttdata.co.jp

Abstract　With the wide spread of the Internet and the mobile communications, we are freed from the restriction of time and the place and able to communicate with others anytime and anywhere. However, we often need to know the situation to whom we communicate before conversation. In such circumstances, it is important to provide users with useful context information.
To facilitate communications, we propose an ambient communication that enables users to communicate without setting the addressee and easily get through the content of what he/she is to communicate. In this paper, we describe an overview of the ambient communication system and introduce the context awareness platform realizing such system. And, we explain the effect that Ambient Communication provides.

Keyword　ubiquitous, communication, presence, context awareness, RFID

1. Introduction

The spread of the Internet and mobile phone has enabled us to communicate without any restrictions of time and space. The very fact, however, that we have no restriction has also led to the need for communication with some means of knowing the situation of the party with whom we wants to communicate (“communicatee”). Generally, the person wanting to establish communication (“communicator”) will communicate with the communicatee by choosing either a synchronous communication such as a face-to-face communication or an asynchronous communication such as an e-mail, the choice depending on the level of urgency of the matter. In these communication styles, there still remain risks that the communication fails. For example, in synchronous communication, the communicator may telephone the communicatee and not be able to grasp his/her whereabouts because he/she may be absent or engaged in a meeting. And in the asynchronous communication, the communicator can convey the message without having to concern about the situation of the communicatee. But, the interaction between the communicator and communicatee that is the intended purpose of the synchronous interchange may not take place.
Thus, we have freed from the restrictions of time and place, but communicator can not easily communicate with communicatee without regard to the communicatee’s situation.
The situation of the communicatee matters not only in private life but also, and even more so, in the office environment, where communication is required more frequently.

1.1. Ubistyle Office Collaborator

In response to the above problems, the authors have developed Ubistyle Office Collaborator (“Collaborator”), a communication tool designed to facilitate communication in the office by providing situation about persons and things. Collaborator obtains and notices personal position information from Radio Frequency IDentification (RFID) tag information, information about the number of person using the meeting room, and information about meeting room reservations and presence information (status messages: FREE, BUSY, DND (Do Not Disturb), N/A). The user establishes communication after referring to the contact list screen on his/her PC (Personal Computer at each desk) or mobile phone and checking the communicatee’s situation and the availability of vacant meeting rooms (Fig. 1). Collaborator has four goals:

1. When the communicator wants to establish synchronous communication, Collaborator can reduce the possibility of synchronous communication mismatch by providing the communicator with information about the position of the communicatee.
2. Collaborator can assess whether synchronous communication is possible or not by using the presence information about the communicatee.
3. Collaborator can activate informal communication in the office.
4. Collaborator facilitates synchronous communication to make efficient use of the meeting room.

In order to evaluate whether Collaborator achieves the above goals, we have conducted in-house user studies starting in October 2004. In March 2005, we conducted a questionnaire to the participants.

The questionnaire results showed that 39% of the test users answered the question concerning goals 1 and 2 above, i.e., the question “Were you able to go and meet the communicatee directly after confirming his/her situation?” in the affirmative. In response to the question “Did you change your means of communication after confirming your communicatee’s situation?” 47% of the test users answered that they had been able to select a more appropriate communication means. The responses to these questions indicate that Collaborator with its capability of providing information about the communicatee’s situation is effective in facilitating communication. On these grounds, the main factor accounting for the fact that about half of the test users did switch to some other communication means may presumably be due to the extra burden placed on the communication. For, whereas the communicator had to select only a single communication medium before he now has to select the communication medium in response to Collaborator’s display of the user’s situation.

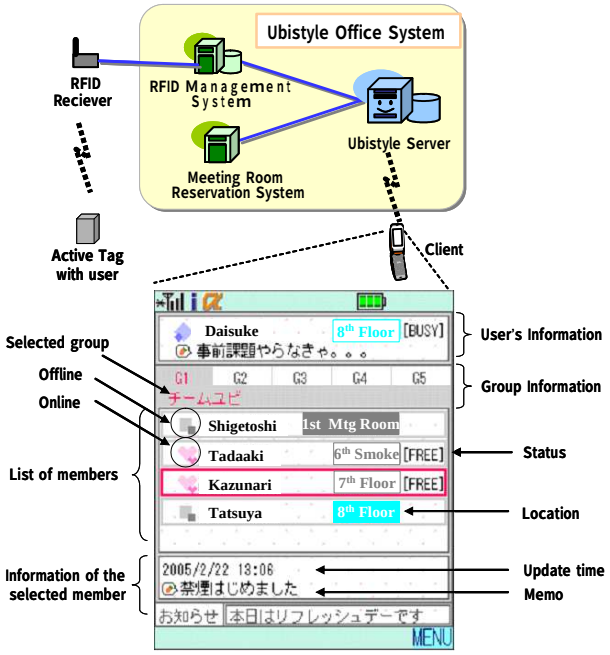

Fig. 1 Ubistyle Office Colaborator

Concerning the third goal, in order to ascertain whether Collaborator had been able to encourage informal communication, we asked the following question: “Were you able to get a sense of being connected from the sharing of situation and messages?” The questionnaire results showed that 54% of the test users felt “they had a sense of being connected.” On the other hand, 46% answered they “did not have a sense of being connected.” This suggests that it is difficult to activate informal communication by sharing situation about the user alone.

Concerning the fourth goal, regarding to the meeting room situation, the respondents gave a positive evaluation of the effectiveness of displaying the reservation and usage status of the meeting room. However, the display of such information alone did not provide an opportunity for actually establishing synchronous communication in the meeting room.

1.2. Ambient Communication

The authors have expanded the initial goals and determined the following new goals after discussion of the questionnaire results.

1. Trying to ease the extra burden placed on the communicator to make it easier for him/her to establish communication.
2. Making it possible to share situation that provides a sense of being personally connected.

In order to accomplish a type of communication capable of achieving the two goals above, we propose the ambient communication that permits the automatic setting of the communicatee in accordance with the situation surround the communicator so as to easily transmit communication contents.

To initiate ambient communication, a communicator requests it to the system with a simple action such as pressing a button on the RFID tag. When the system receives this request, it starts to infer with whom he should contact taking his/her context or situational information into account, and then the system sends just simple information such as communicator’s name or address. The communicatee then looks up under what situation the communicator has sent his/her communication and is thus able to understand the intention of the communicator’s communication. By using such ambient communication, the communicator is freed from the burden of explicitly presenting the contents of his/her communications with the existing media such as e-mail or chat in order to convey the mere purport of his/her communication.

Regarding the first goal above, using this ambient communication, the communicator need not:

- select the communicatee
- select the communication medium
- transmit the contents of his communication

to convey the mere purport of his communication. In this way, ambient communication reduces the burden placed on the communicator.

Since this kind of notification is to originally imply that a communicator want a communicatee to see his/her situation, we believe that the ambient communication will also achieve the second goal. This may provide what Ito et al. have described as the “TSUNAGARI”, a kind of sense of being connected [6].

When ambient communication is applied to in-house office communication, for example, the following type of communication will be expected.

1. Before the beginning of a meeting, the organizer of the meeting sends ambient communication toward all scheduled participants. (Through this communication, the participants will be aware of the meeting)

2. As a matter of form, ambient communication is sent in the morning or at lunch. (This may take the form of a signaling to them messages such as “Good morning. How are you?” or “Come on, let’s go out for lunch.”)

The establishment of the type of communication described in these examples is likely to bring about the following changes of an office communication.

1. By using ambient communication, we can easily establish routine communication rather than using the telephone or e-mail.
2. Being able to communicate easily, the amount of the office communication will result in an increase overall. The changes bring us to grasp the situation and induce synchronous communication.

Chapter 2 below introduces related works and has a clear distinction of the positioning of our research. Chapters 3 and 4 give details about the ambient communication layer needed for achieving ambient communication and the contextaware platform that is the basis of ambient communication. Chapter 5 describes the prototype system that has been configured to achieve ambient communication. Finally, chapter 6 notes on the future work.

2. Related Work

There are a lot of works to facilitate smooth communication, such as Nakanishi et al.’s iCAMS [2], Allen et al.’s LiveAddressbook [3], and John et al.’s Awarenex [4]. Similarly to Collaborator, in these analogous works, the communicator is likewise able to know the situation of the communicatee. However, these communication tools or systems were not taken into account of the communicatee’s situation.

The predecessor of the above work [2] was CAMS [5]. This system provided availability by automatically determining the target address at each medium such as the telephone number or the e-mail address. It uses location information and schedule information to estimate the situation but does not go as far as to automatically determine the communicatee.

Two research projects have been done concerning the communication that does not use words or letters. One is Ito et al.’s ‘TSUNAGARI’ Communication. They propose a new type of communication of sharing clue-providing information as they focus that the relations of family members living in a dispersed environment become tenuous and the individual has an increasing sense of loneliness. Family Planter System used to evaluate the validity of this communication focuses on personal interpretation without using words or saying to convey the intent of the communication in exactly the same as our ambient communication. But they mentioned that the clue-providing information is not something that is understood be everybody but is aimed at the family where basic human relations are established. The approach we have adopted in this paper is this: By providing information about the user and about things that has been obtained from a ubiquitous environment, it is possible for all the communicatee to understand the purport of the communication.

The other is Ishii et al.’s Tangible Bits [7]. They have their problem consciousness to the fact that “the skills we have acquired by directly touching and manipulating (operating) things and the awareness we have gained through our sensation of the ambient environment are not being applied in the present Graphical User Interface (GUI)”. The Tangible Bits project carries out research on the Water Lamp and the ambient ROOM, for instance. They focus attention especially on the human interface and studies issues related to information tactility/peripheral sense using the ambient media. In Tangible Bits, the communication element is rather tenuous.

3. Context Awareness and Ambient Communication

In ambient communication, the system automatically determines, by a simple action of the communicator, whether the communicator should establish communication with somebody on the basis of the situation or whereabouts of the communicator and the purpose of communication and the system informs the communicator that the action has been detected.

The concept of selecting the appropriate communicatee according to the circumstances has a similarity to context aware computing that is being talked about in the ubiquitous computing. In the context aware computing that is based on electronic tagging and sensing technology, the information surrounding the user such as the user’s environment or situation is called context. The objective of context aware computing is to provide the optimum information and service for the task aimed by the user by becoming aware of this context. (Fig. 2)

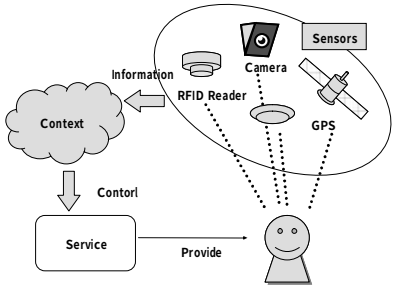

Fig. 2 Overview of Context Awareness

It is obvious that context aware computing can be utilized as the basis for achieving ambient communication. We propose a system architecture shown in Fig. 3 for achieving ambient communication. When communicator establishes communication with communicatee, the system informs the communicatee selected by ambient communication layer. The communicatee's decision use situation acquired from a context aware platform.

We are proposing Application Oriented Context Awareness (AOCA) and are developing the YACAN (Yet

Another ContextAwareNess) framework for achieving AOCA.

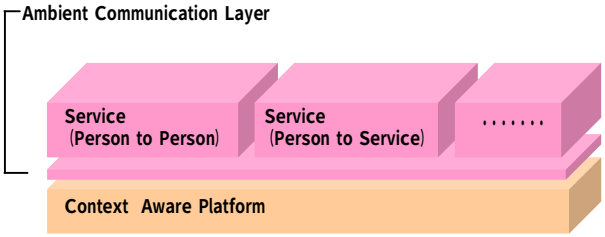

Fig. 3 System Architecture

3.1. AOCA

When the AOCA application developer designed the application, he chose the use environment information as the context and also provided the context-judging logic. Depending on this context, the application can specify the environment and situation that serve as the occasion for providing the service.

The context configured by the application developer may be seen as the various situation factors that make it possible, from the application developer's viewpoint, to understand the environment, based on sensing data and user profile. When a context is changed and used as environment information of an increased level of abstraction to serve as a constituent element of another context it is possible to generate a context configuration of a higher degree of abstraction, by using the understanding of the environment that already exists. By interpreting the various environment settings and situation contexts construed by the application developer as the context and storing these contexts, it becomes easy to develop a context aware application.

The AOCA framework has a three-tier architecture (Fig. 4) consisting of a context-managing context layer interspersed between the content layer and the application layer.

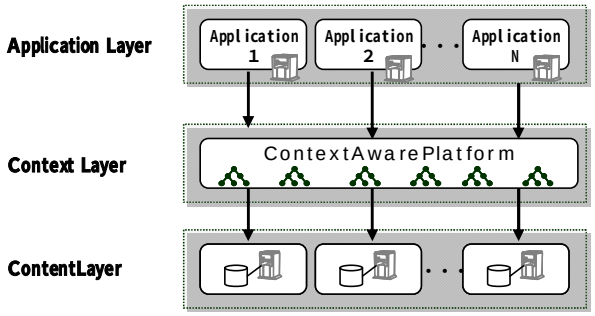

Fig. 4 Schematic View of AOCA Framework

By abstracting the information obtained from the content layer from the context and transmitting it to the application, it is possible to reduce the mutual dependence between the application developed and the content manager. As a result, it is possible to support in a flexible manner any variations in the number or types of contents and any addition, deletion or expansion of applications.

3.2. YACAN

YACAN consists of four basic components: the Content Provider, the Context Manager, the Content Broker, and the Context Repository. Constituent View of YACAN is shown in Fig.5.

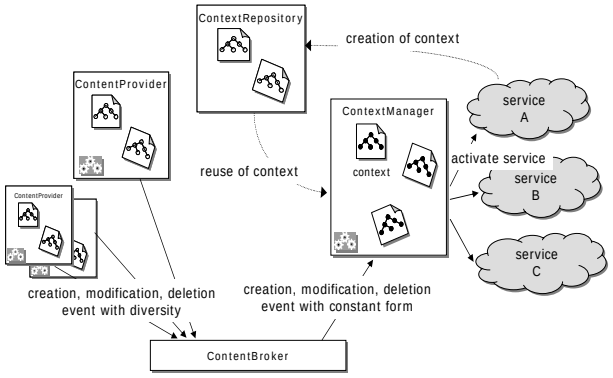

Fig.5 Constituent View of YACAN

1. Content Provider
   The Content Provider manages contents, and has the function of function to notify the change event (creation, modification, deletion) in contents.
2. Content Broker
   The Content Broker absorbs the diversity of the notification protocol for the Content Provider events and notifies content alteration events in a protocol that is integrated in the Content Manager.
3. Context Manager
   The Context Manager receives the content alteration events from the Content Broker and provides the service in accordance with the context.
4. Context Repository
   The Context Manager receives the content alteration events from the Content Broker and provides the service in accordance with the context.

4. Ambient Communication Layer

Based on the AOCA framework, we have designed the basic architecture realizing the ambient communication. While the AOCA framework is responsible for context management including publishing changes of context, Ambient Communication Layer is mainly to responsible for analyzing data of a context which is provided from the AOCA framework and initialization of the communication by means of the results of context analysis and communication list which is managed in this layer.

4.1. Overview of the Ambient Communication layer

Our goal is to realize ambient communication which users do not always have to specify their communicatee when they start communication. Taking this into account, we designed its basic architecture as a first step. The following shows the sequence diagram of how the

ambient communication layer works (Fig. 6).

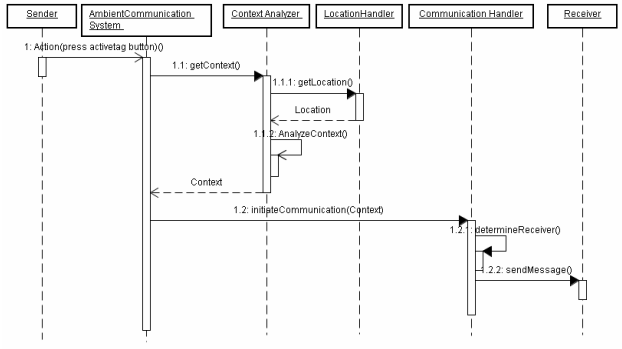

Fig. 6 Sequence Flow

1. The context aware platform detects a request for ambient communication and initializes the system. This activation phase may include various user actions such as pressing the active tag button.
2. The ambient communication layer receives the context information with parameters and passed it to its context analyzer. Context information is a collection required for deducing the situational information of the user These kind of context is to be pre-defined and managed in this .layer
3. The context analyzer gathers information on the basis of the context-defining information to analyze the communicator's context (sequence no. 1.1). When the entire volume of collectable information might not be able to be retrieved in the AOCA framework caused by some reasons such as session invalidation, we accept it and the context analyzer is to calculate the context from the information that can be collected in that situation.
4. The layer determines the communicatee as the communication partner and then acquires his/her address from preserved contact information storage. When sending, the transmitting and receiving of information whose arrival cannot be guaranteed is enabled.

4.2. Components for Ambient Communication

The components are on the top layer of the AOCA framework. Fig.7 shows overall architecture of the ambient communication layer and it mainly contains three kinds of functional component. When the AOCA detects a request for ambient communication, then the AOCA passes it to this layer. Each functional component is to work as follows;

1. Activator
   The Activator detects the change in content information that triggers ambient communication and/or user action and acquires the corresponding ID information.
2. Context Analyzer
   The Context Analyzer analyzes the situation with the data of the context comes from the AOCA platform. It determines users' situations as an abstract context information in a certain manner stored in this layer.
3. Communication Controller
   The Communication Controller is to transmit a message or initiate a call. Before communication, it fetches contact lists, which are the set of the communication address and communication media, corresponding to the context. To fetch the data, it also refers to the general rules such as "Conference Participants in Case of Conferences in Progress," "Group Members in Case it's Morning," or the lists which are customized by the senders/receivers themselves.

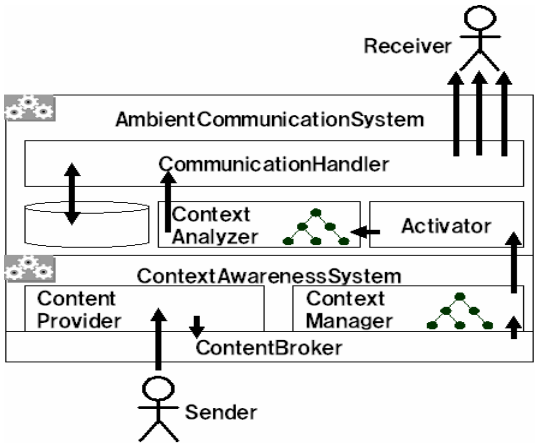

Fig. 7 Schematic View of Architecture

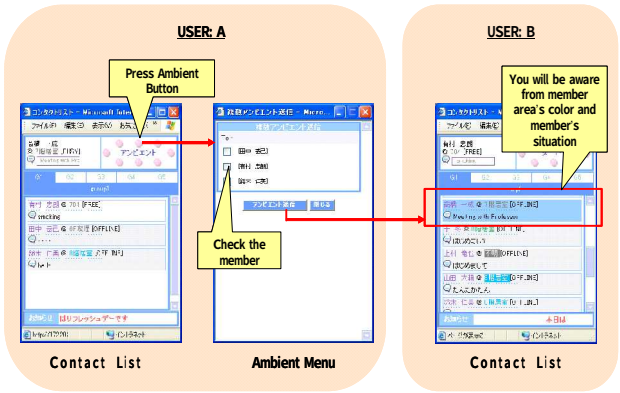

Fig. 8 Prototype System

5. Prototype Mounting

In achieving ambient communication, the ambient communication layer, as we noted before, is necessary. The prototype system focuses on the communicatee interface. Collaborator has added functions and installed on it an ambient communication interface (Fig. 8) for selection by the communicator without having the system automatically perform setting of the communicatee. The communicator selects members who want to engage in communication from the ambient communication menu. He/She (the communicator) then performs the steps for transmission. It is possible to

check on the contact list of communicatee that communication is received as the communicator member area changes color. By carrying out a validation test with this system, it can be assessed whether the communicatee has been made aware of the communicator's intention to communicate.

6. Direction of Future Development

In ambient communication, the communication partner (communicatee) is selected and bits are transmitted in accordance with the situation context or purpose detected by the context aware platform. Thus, the key to enhancing the usability of ambient communication lies in the way in which the user situation context or purpose can be detected by the system (context aware platform).

The AOCA proposed in this paper expresses the situation context as a conceptual structure and handles the generated situation context as an instance generated in accordance with the concept. The ambient communication layer achieved by using the context aware platform YACAN which uses AOCA is capable of conceptualization and permits concrete specification of the targets that already know the method of accessing the contents necessary for actualization.

While AOCA is capable of expressing the objective situation context relating to the user on the basis of sensed information the user is not able to handle the purpose and background as to the user's intent that may have led to a certain situation context. For this reason, it is possible to achieve ambient communications related to the given situation context, but it is not possible to actualize ambient communication in accordance with the purpose.

In this regard, we are examining the way in which the user's purpose is inferred based on the meaning of the office environment [9]. Thus, for example, the objective is to configure a model for expressing the meaning of the office environment and a purpose-deducing engine to permit the deduction that in the office environment the "purpose intended by the user who is in the conference room is to hold a meeting." The "purpose-deducing engine may not only be capable of considering the purpose given by the meaning of the office environment but may also be capable of some more accurate purpose inference allowing for user schedule data and co-participants, by taking into account the objective situation context expressed by AOCA. For this purpose, we are planning to proceed with the establishment of a real-world oriented information model including user and time information that was not taken into account in the AOCA and we also intend to move ahead toward the creation of a descriptive system for the mutual dependence relationships.

7. Conclusion

In this paper, we have proposed ambient communication that lets the communicator select the communication receiver (communicatee) in accordance with the situation context and transmits bits to provide the trigger necessary for the communicatee to be made aware of the situation context. The authors plan to evaluate through validation tests to what extent the ambient communication supporting Collaborator can contribute to the generation of a "sense of being connected" in the office. The results of this evaluation will be reported in our next publication.

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