Context-Based Seamless Network and Application Control

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ABSTRACT

A context-based adaptive communication system is introduced for use in heterogeneous networks. The context includes user's presence and profile such as location, available network interfaces, network availability, network priority, terminal features, and installed applications. The system operates on a seamless networking platform we developed for heterogeneous networks. By using contexts, the system, in advance of communication, shows a caller and its callee applications that are available through the network they can get access to. Changes of the contexts can switch the on-going application to another during communication. These features provide us unprecedented styles of communications.

Keywords

Context, seamless handover, presence, network selection

INTRODUCTION

In heterogeneous networks, radio access network (RAN) discovery is a vital feature because a user who wants to communicate at a specific geographic location first needs to find out which RANs are available in that area. Seamless handover to different RANs will also be needed [1].

These features would help new styles of communication emerge. One is the selection of networks based on factors such as the user's preference, communication speed, and availability. Another is the use of information about the callee (location, availability, connectivity, etc.). These considerations motivated us to develop the idea of using context for the management of network and services. The system was developed on a seamless network platform called MIRAI ("future" for Japanese).

CONTEXT PROCESSING

Context information, in this paper, includes the user's presence, location, available network interfaces for his/her mobile terminal, network availability, network priority, communication status, applications installed in the terminal, and the user's profile. The system was designed to show a user all the applications that can be performed using available networks. The user only needs to select an application among them. Figure 1 illustrates the process of selecting an application for users.

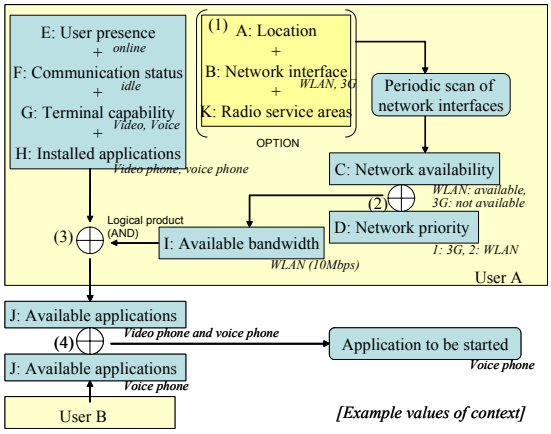

Figure 1. Context processing procedures.

IMPLEMENTATION

Figures 2 and 3 show the network configuration and functional architecture. The MIRAI agent is a major logical component in a home network. We implemented all the functions for multi-service user terminal (MUT) on a laptop PC and a PDA. Ethernet, WiFi, Personal Handyphone System (PHS), 2G cellular, and 3G cellular were used as (radio) access networks. We used Mobile IPv4 to support terminal mobility.

The MIRAI agent works as a Basic Access Signaling (BAS) server for exchanging signaling messages between users and the network, a Mobile IPv4 home agent for providing mobility features, a SIP proxy server for providing session management and presence exchange functions, and a resource server for the management of user data and for the provision of information about coverage and speed of RANs.

In an MUT, the seamless agent controls Mobile IP function, network connection and handover, and signaling with the network. The SIP client performs SIP signaling. The SIP client requests the seamless agent to establish connection to a RAN, and manages SIP applications.

The graphical user interfaces of the seamless agent are shown in Fig. 4. The main window shows that user "ISHIZAKI" is online. Her personal information window shows her location, SIP address, and network status. Ethernet is used as a BAN (signaling channel) while 802.11b is used for a data connection. It is also shown that 802.11a is not used though it is available, and other interfaces are

unavailable. The partner window displays information on user "homa" who is selected in the main window. The main window has a "Call Button". This icon changes according to the result of context processing described earlier, and indicates any one of "unable to communicate", "voice mail", "voice phone", and "video phone".

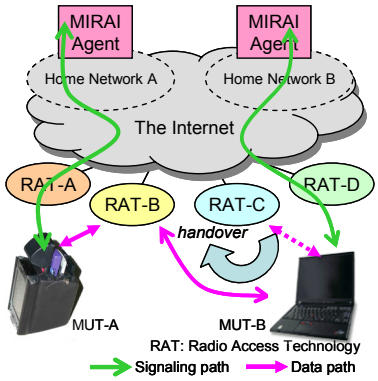

Figure 2. Network configuration.

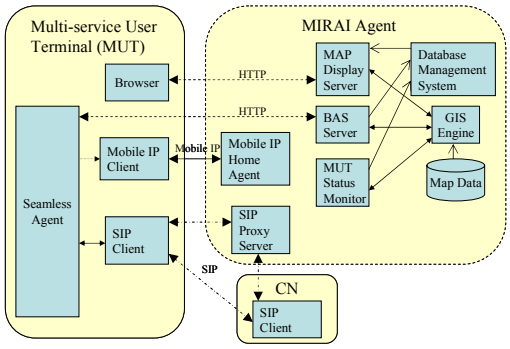

Figure 3. Functional configuration.

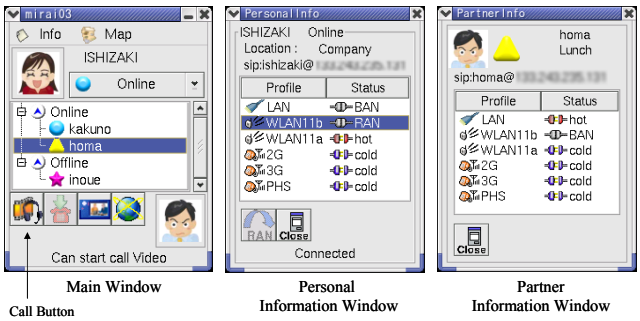

Figure 4. User interfaces of seamless agent software on multi-service user terminal (MUT).

FEATURES AND DEMONSTRATION

Power saving function enables MUTs to activate only the network interfaces that are needed while keeping all other unused interfaces off. Context-based seamless network handover function makes it possible to hand over a connection from one RAN to another. The system also features context-based seamless application handover function that changes the application being executed to another without disrupting communication. Seamless terminal handover function allows a user to change the end terminal using SIP functions without terminating the connection. The system also features a function that it always tries to establish a connection to a network of higher priority. These functions allow users to leave a message when a callee is not available, to change application from video phone to voice phone when the bandwidth of end-to-end network has become narrow, and to restart video phone when the bandwidth has recovered. Figures 5 to 7 show pictures of explaining seamless handovers of network, application, and terminal.

Figure 5. Laptop MUTs performing video phone through a broadband connection: left) user A's windows, right) user B's windows.

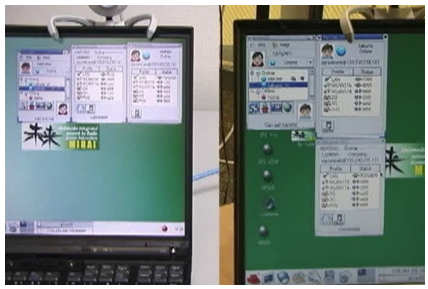

Figure 6. Video stream has been suspended because the bandwidth became narrowband as user A moved. Only voice stream continues to flow.

Figure 7. Video stream has been resumed because user A transferred the phone connection to a desktop PC with a broadband network.

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REFERENCE

[1] M. Inoue, K. Mahmud, H. Murakami, M. Hasegawa, H. Morikawa, "Novel Out-Of-Band Signaling for Seamless Interworking Between Heterogeneous Networks," in IEEE Wireless Commun., Apr. 2004.