Chapter 8
Agent-Based Middleware for Advanced Communication Services in a Ubiquitous Computing Environment

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ABSTRACT

In a ubiquitous computing (ubicomp) environment, system components of different types, including hardware elements, software components, and network connections, must cooperate mutually to provide services that fulfill user requirements. Consequently, advanced and flexible characteristics of software that are specialized for a ubicomp environment are needed. This paper presents a proposal of an agent-based middleware for a ubicomp environment comprising computers and home electric appliances. The middleware, called AMUSE, can take quality of service (QoS) in a ubicomp environment into consideration by coping not only with user context but also with the resource context, using agent-based computing technology. Herein, we describe the concept, design, and initial implementation of AMUSE. Simulation results of an experimental ubiquitous service using AMUSE demonstrate the effectiveness of our proposed scheme. Additionally, to confirm our scheme's feasibility and effectiveness, we describe the initial implementation of a multimedia communication application based on AMUSE.

INTRODUCTION

In recent years, studies of ubiquitous computing (ubicomp) (Weiser, 1991) environments and service provision in such environments have increased quickly. Two mainstreams exist in studies of ubiquitous services: research into user contexts in the environment, and service construction schemes. User context studies mainly investigate advanced methods for obtaining a user's physical location and determine appropriate services from location information and user profiles (Bellavista, 2003). In contrast, studies of service construction propose superior frameworks and schemes designed for dynamic cooperation among system components of many kinds—entities in a ubiquitous environment—to provide user-oriented services (Itao, 2002; Minoh, 2001; Iwamoto, 2003; Minami, 2003; Nakazawa, 2001; Gribble, 2001).

Discussions of actual applications of ubiquitous services have mainly addressed remote control of home electronics appliances from portable devices and information delivery systems based on a user's location information. Users' future demands on these ubiquitous services are expected to move into much richer applications such as multimedia communication services. Consequently, we are promoting research and development of fundamental technologies aimed at post-ubiquitous computing environments, including multimedia service provision through cooperative use of audio-visual home electronics appliances. We are targeting services such as video streaming and videoconferencing constructed through coordination of available computers, portable devices and home appliances, as portrayed in Figure 1.

To provide necessary and sufficient QoS that satisfies user requirements is an intrinsic problem to realize such ubiquitous services. To address this, we must consider not only the user context, but also the resource context of hardware, network, and software. This is true because resource availability tends to be poor and unstable in a ubiquitous environment. Furthermore, multiple users would be given ubiquitous services simultaneously; for that reason, problems of effective resource sharing and assignment should be addressed.

As described in this paper, we are aiming at investigating ubiquitous service construction scheme to provide QoS-aware and stable services against changes of resource status and the user's situation. We proposed a unique idea of effective handling of multiple contexts including the user context and resource contexts. To accomplish the

Figure 1. Application of ubiquitous service provided by multimedia home electric appliances
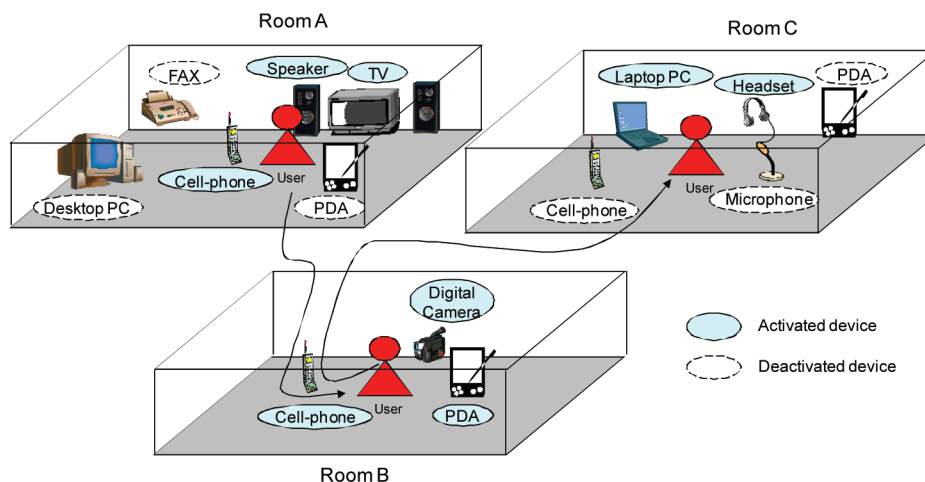
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