Chapter 7
Dynamic Adaptation in Ubiquitous Services:
A Conceptual Architecture

Moeiz Miraoui
University of Gafsa, Tunisia

ABSTRACT

Ubiquitous (or Pervasive) Computing is a new domain in Computer Science resulting from the emergence and evolution of both distributed systems and mobile computing. Technology is moving beyond the personal computer towards a growing trend of embedded microprocessors in everyday objects and is demanding an unobtrusive connectivity between them in order to serve users at anytime and anywhere. The main objective of a ubiquitous computing system is to provide adaptive services proactively, without explicit user intervention and according to the user's current context. Despite interesting previous research works, there is still a lack of software tools and related research in terms of comprehensive context modeling, architecture of context-aware ubiquitous systems, and dynamic adaptation approaches in ubiquitous service computing environments. This chapter proposes a conceptual architecture to provide dynamic adaptability in ubiquitous services based on context-awareness and user preferences. As part of this proposal, the authors detail an ontology-based context modeling approach, a multi-agent architecture to support the development of ubiquitous computing applications, and a case-based reasoning method for service adaptation.

INTRODUCTION

The concept of *Ubiquitous* (or *Pervasive*) *Computing* was presented in a conference article by Mark Weiser (1991), where he described a twenty-year horizon for the future of computing. Ubiquitous computing is the result of computer technology advancement, particularly in distributed and mobile computing. Technology is moving beyond the personal computer to everyday devices with embedded intelligence. The goal of these systems is to assist the user implicitly and discreetly in tasks that are performed daily. The current technological developments contribute to the realization of the vision of Mark Weiser. Today, the user is surrounded by many smart devices, such as laptops, smart phones, smart tablet computers, GPS, etc. as objects of everyday life. The task of using and managing these devices can become complex and time consuming without these devices being context-aware and proactive, by providing services conforming to the user's current context without the explicit intervention of the user.

Consequently, *Context-awareness* is the principal characteristic of ubiquitous computing applications. One of the primary tasks of designing ubiquitous computing applications consists of understanding context and establishing its components. *Context modeling* is an important step in the development of ubiquitous computing applications. Many methods have been proposed for context modeling related to different techniques, and some of the most interesting ones are based on ontology. But they still suffer from the problem of being specific to certain situations which limits their use to particular applications.

Ubiquitous computing is a new computer science paradigm that requires new tools and methodologies to satisfy ubiquitous computing requirements. Researchers have proposed archi-tectures, middlewares, and frameworks to support the development of ubiquitous computing and context-aware applications. Most of these architectures use either a layered approach based on the context sensing processes, or provide modular building blocks. Each approach promotes a set of software qualities. However, only a small number of the existing architectures satisfy the requirements of ubiquitous and context-aware systems to a significant extent. After all, the aim of a ubiquitous service computing system is to provide adapted services based on the user's current context, without manual intervention of the user. This adaptation should take into account not only *current context* but also *user preferences* and *limited resources of devices* which are generally hand held in the ubiquitous environment.

This chapter discusses the challenges and promising solution approaches associated with developing ubiquitous service computing applications. The remainder of the chapter is organized as follows: the background section presents the related works on context modeling, architectural aspects of ubiquitous computing systems, and ubiquitous service adaptation. The following sections describe an ontology-based context modeling approach, introduce a multi-agent architecture for building ubiquitous service computing systems, and present a case-based reasoning approach for dynamic context-aware service adaptation in a ubiquitous computing environment. The final section summarizes key points and lessons learned.

BACKGROUND

This section presents an overview of research works on context definition and modeling, software architecture of context-aware systems, and dynamic service adaptation.

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