Chapter 2.7
An Adaptable Context Management Framework for Pervasive Computing

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ABSTRACT

Pervasive computing presents an exciting realm where intelligent devices interact within the background of our environments to create a more intuitive experience for their human users. Context-awareness is a key requirement in a pervasive environment because it enables an application to adapt to the current situation. Context-awareness is best facilitated by a context management system that supports the automatic discovery, retrieval and exchange of context information by devices. Such a system must perform its functions in a pervasive computing environment that involves heterogeneous mobile devices which may experience intermittent connectivity and resource and power constraints. The objective of the chapter is to describe a robust and adaptable context management system. We achieve an adaptable context management system by adopting the autonomic computing paradigm, which supports systems that are aware of their surroundings and that can automatically react to changes in them. A robust context management system is achieved with an implementation based on widely accepted standards, specifically

Web services and the Web Services Distributed Management (WSDM) standard.

INTRODUCTION

Pervasive computing describes a state in which devices are so pervasive and critical to our activities that they are taken for granted and effectively disappear into the background (Weiser, 1991). Recent technological advances have produced devices small and sophisticated enough to provide the necessary hardware infrastructure for creating pervasive environments.

As our attention turns to the software needed to support this paradigm, we see that a key property that differentiates pervasive computing applications from traditional applications is that a pervasive application has the ability to process and share information about itself and its surrounding environment, that is, to be *context-aware*. This context-awareness acts as a cushion between the technology and the user. It allows users to interact with applications in a more intuitive way and so improves their usability.

Context has a variety of definitions in the pervasive computing literature (Chen & Kotz, 2000, Strang & Linnhoff-Popien, 2004, daCosta, Yamin & Geyer, 2008). Dey (2001) describes context as information that can be used to characterize the situation of an entity, where an entity can be a person, location or object relevant to the interaction between a user and an application. Following from this definition, we can say that a system or application is context-aware if it uses context to provide information or services relevant to the user's task (Dey, 2001). For instance, a smart thermostat's context information includes details about its location, functionality, and information on how to access its temperature controls. Upon entering the vicinity of a smart thermostat, a context-aware PDA would be able to detect its presence, determine that it is a smart thermostat, and obtain information on how to access and manipulate the current room temperature.

In this chapter we argue that context-awareness should be supported by a context management system that allows the automatic discovery, retrieval and exchange of context information by devices. Such a system must perform its functions in a pervasive computing environment that involves heterogeneous mobile devices which may experience intermittent connectivity and resource and power constraints. An effective context management system for a pervasive environment must therefore have two key properties, namely robustness and adaptability.

A robust context management system is achieved with an implementation based on widely accepted standards. While various context management solutions, such as CoBrA (Chen, Finin & Joshi, 2004) and PersonisAD (Assad, Carmichael, Kay and Kummerfeld, 2007), are available, a standardized solution has not, to the best of our knowledge, been proposed. We describe an implementation of our context management framework that integrates several existing technologies and standards and so can be used across disparate devices, software platforms and physical environments.

An adaptable context management system is able to automatically adjust to changes in its environment, for instance users disconnecting and reconnecting to the pervasive environment or a user moving around within the environment. An adaptable context management system supports context-awareness through the automatic discovery of changes in the environment and enhances usability by insulating users from the changes by automatically adjusting to them.

The objective of the chapter is to describe a robust and adaptable context management system. We first propose our Adaptable Context Management Framework (ACMF). It defines a context model and a set of context exchange protocols. ACMF views each device in terms of the *roles* it plays with respect to context management. The possible roles include client, server and proxy.