Chapter LV
Concepts and Architectures for Mobile Context-Aware Applications

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ABSTRACT

Context-awareness has been investigated for almost a decade and is considered as a convenient and desirable feature in distributed mobile systems since it allows these systems to benefit from the changes in their users' context to dynamically tailor services to their users' current situation and needs. This chapter addresses the research results and challenges of designing a flexible infrastructure to support the development of mobile context-aware applications. We discuss relevant context-awareness concepts, define architectural patterns on context-awareness, present the design of a target infrastructure, and discuss some related research and research trends. The context-aware infrastructure described in this chapter follows the principles of service-oriented architectures in which the dynamic customization of context-aware mobile services is specified by means of application behavior rules that are interpreted and applied by the infrastructure at runtime.

INTRODUCTION

The notion of context-awareness was introduced when the research community started to realize that there was "something more than the user's location" that could be used to enhance the services delivered by distributed applications (Schmidt, Beigl & Gellersen, 1999). Context-awareness refers to the capabilities of applications that can provide relevant services to their users by sensing and exploring the users' contexts. In addition to the user's location, the user's context often includes environmental aspects (e.g., temperature, humidity), technological aspects (e.g., devices, applications), social aspects (e.g., tasks, activities, objectives) and even psychological aspects (e.g., mood) (Chen, Finin & Joshi, 2003). Context-awareness has emerged as a convenient and desirable feature in distributed mobile systems since it benefits from the changes in the user's context to dynamically tailor services to the user's current situation and needs (Dockhorn Costa, Ferreira Pires & van Sinderen, 2004).

Developers of context-aware applications have to face some challenges, such as (i) bridging the gap between information sensed from the environment and information that is actually syntactically and semantically meaningful to these applications; (ii) modifying application behavior (reactively and proactively) according to predefined condition rules and (iii) customizing service delivery as needed by the user and the user's context. These challenges require proper software abstractions and methodologies that support and ease the development process of these applications.

In this chapter, we discuss relevant context-awareness concepts and present the design of an infrastructure that supports mobile context-aware applications. Our approach tackles the challenges mentioned previously by providing a service-oriented architecture in which the dynamic customization of services is specified by means of application-specified behavior rules that are interpreted and applied by the infrastructure at runtime.

We present three architectural patterns that can be applied beneficially in the development of context-aware services infrastructures; namely, the Event-Control-Action pattern, the Context Sources and Managers Hierarchy pattern, and the Actions pattern. These patterns present solutions for recurring problems associated with managing context information and proactively reacting upon context changes, and can be identified in many different developments in this area.

The remainder of this chapter is structured as follows: Section 2 characterizes context-awareness by introducing a definition of context, its properties, and interrelationships; Section 3 discusses context-aware services infrastructures by identifying their potential benefits, challenges, solutions, and design guidelines; Section 4 presents the architectural patterns we have identified and applied in our own research; Section 5 introduces an infrastructure that supports the development of context-aware applications; Section 6 discusses some related research and research trends; and Section 7 gives final remarks and conclusions.

CONTEXT-AWARENESS

The Merriam-Webster online dictionary (Merriam-Webster, 2005) provides a general definition of context; namely, "the interrelated conditions in which something exists or occurs." We focus on this definition as the starting point for characterizing context in the scope of context-aware mobile applications. This definition makes clear that it is only meaningful to talk about context with respect to something that exists or occurs, which we call the entity or subject of the context. Since we aim at supporting the development of context-aware applications, we should clearly identify the subject of the context in the scope of these applications.

As opposed to "traditional" applications, context-aware applications implicitly exploit the context of their users to determine how these ap-