Chapter XXXI
Architectural Support for Mobile Context-Aware Applications

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ABSTRACT

Context-awareness has emerged as an important 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. This chapter presents our efforts on 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 and present the design of the target infrastructure. Our approach towards this infrastructure includes the definition of a service-oriented architecture in which the dynamic customization of services is specified by means of description rules at infrastructure runtime.

INTRODUCTION

Context awareness refers to the capabilities of applications that can provide relevant services to their users by sensing and exploring the user's context. Typically the user's context consists of a collection of conditions, such as the user's location, environmental aspects (temperature, light intensity, etc.), and activities (Chen, Finin, & Joshi, 2003). Context awareness has emerged as an important 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 pre-defined condition rules; and (iii) customizing service delivery as needed by the user and his context. These challenges require proper software abstractions and methodologies that support and ease the development process.

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

In addition, 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.

The remainder of this chapter is structured as follows: The section "Context Awareness" presents general aspects of context awareness, such as the definition of context, its properties and interrelationships; the section "Context-Aware Services Infrastructures" discusses the role of applications, application components and infrastructure in our approach, the section "Context-Aware Architectural Patterns" presents the architectural patterns we

have identified, and the section "Services Infrastructure Architecture" introduces an infrastructure that supports the development of context-aware applications, the section "Related Work" relates our work to other current approaches, and the last section gives final remarks and conclusions.

CONTEXT AWARENESS

In the Merriam-Webster online dictionary (Merriam-Webster, 2005) the following definition of context can be found: "the interrelated conditions in which something exists or occurs." We focus on this definition as the starting point for discussing 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 this area.

Context-aware applications have been devised as an extension to traditional distributed applications in which the context of the application users is exploited to determine how the application should behave. The services offered by these applications are called context-aware services. Furthermore, these applications have means to learn the users' context without explicit user intervention. We conclude then that in the case of context-aware applications, context should be limited to the conditions that are relevant for the purpose of these applications. The subject of the context in this case can be a user or a group of users of the context-aware services, or the service provisioning itself.

When considering context-aware applications, we should not forget that context consists

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