Chapter 8.1
Bridging Together Mobile and Service–Oriented Computing

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INTRODUCTION

The growing popularity of powerful *mobile devices,* such as modern cellular phones, smart phones, and PDAs, is enabling *pervasive computing* (Weiser, 1991) as the new paradigm for creating and interacting with computational systems. Pervasive computing is characterized by the interaction of mobile devices with embedded devices dispersed across *smart spaces,* and with other mobile devices on behalf of users. The interaction between user devices and smart spaces occurs primarily through services advertised on those environments. For instance, airports may offer a notification service, where the system registers the user flight at the check-in and keeps the user informed, for example, by means of messages, about flight schedule or any other relevant information.

In the context of smart spaces, *service-oriented computing* (Papazoglou & Georgakopoulos, 2003), in short SOC, stands out as the effective choice for advertising services to mobile devices (Zhu, Mutka, & Ni, 2005; Bellur & Narendra, 2005). SOC is a computing paradigm that has in services the essential elements for building applications. SOC is designed and deployed through *service-oriented architectures* (SOAs) and their applications. SOAs address the flexibility for dynamic binding of services, which applications

need to locate and execute a given operation in a pervasive computing environment. This feature is especially important due to the dynamics of smart spaces, where resources may exist anywhere and applications running on mobile clients must be able to find out and use them at runtime.

In this article, we discuss several issues on bridging mobile devices and service-oriented computing in the context of smart spaces. Since smart spaces make extensive use of services for interacting with personal mobile devices, they become the ideal scenario for discussing the issues for this integration. A brief introduction on SOC and SOA is also presented, as well as the main architectural approaches for creating SOC environments aimed at the use of resource-constrained mobile devices.

BACKGROUND

SOC is a distributed computing paradigm whose building blocks are distributed services. Services are self-contained software modules performing only pre-defined sets of tasks. SOC is implemented through the deployment of any software infrastructure that obeys its key features. Such features include loose coupling, implementation neutrality, and granularity, among others (Huhns & Singh, 2005). In this context, SOAs are software architectures complying with SOC features.

According to the basic model of SOA, service providers advertise service interfaces. Through such interfaces, providers hide from service clients the complexity behind using different and complex kinds of resources, such as databanks, specialized hardware (e.g., sensor networks), or even combinations of other services. Service providers announce their services in service registries. Clients can then query these registries about needed services. If the registry knows some provider of the required service, a reference for that provider is returned to the client, which uses this reference

for contacting the service provider. Therefore, services must be described and published using some machine-understandable notation.

Different technologies may be used for conceiving SOAs such as grid services, Web services, and Jini, which follow the SOC concepts. Each SOA technology defines its own standard machineries for (1) service description, (2) message format, (3) message exchange protocol, and (4) service location.

In the context of pervasive computing, services are the essential elements of smart spaces. Services are used for interacting with mobile devices and therefore delivering personalized services for people. Owning to the great benefits that arise with the SOC paradigm, such as interoperability, dynamic service discovery, and reusability, there is a strong and increasing interest in making mobile devices capable of providing and consuming services over wireless networks (Chen, Zhang, & Zhou, 2005; Kalasapur, Kumar, & Shirazi, 2006; Kilanioti, Sotiropoulou, & Hadjiefthymiades, 2005). The dynamic discovery and invocation of services are essential to mobile applications, where the user context may change dynamically, making different kinds of services, or service implementations, adequate at different moments and places.

However, bridging mobile devices and SOAs requires analysis of some design issues, along with the fixing of diverse problems related to using resources and protocols primarily aimed at wired use, as discussed in the next sections.

INTEGRATING MOBILE DEVICES AND SOAS

Devices may assume three different roles in a SOA: service provider, service consumer, or service registry. In what follows, we examine the most representative high-level scenarios of how mobile devices work in each situation.

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