Chapter 3.8
A Database Service Discovery Model for Mobile Agents

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INTRODUCTION

The number of services that will become available in distributed networks (in particular, on the Internet) is expected to grow enormously. Besides classical services such as those offered by printers, scanners, fax machines, and so on, more and more services will be available nowadays. Examples are information access via the Internet, music on demand, Web services, and services that use computational infrastructure that has been deployed within the network. Moreover, the concept of service in mobile agent systems, which will be described in this article, has come into prominence recently.

The mobile agent model is a new distributed software development paradigm as compared to the traditional client-server model. Instead of calling operations on servers with some form of synchronization, the user passes on his or her goal to an agent that can migrate within the computational environment and knows how to handle it without being controlled. In brief, mobile agents are active, autonomous, intelligent objects that are able to move between locations in a so-called agent system. Mobile agents must interact with their hosts in order to use their services or to negotiate services with other agents (Song & Li, 2004). Discovering services for mobile agents comes from two considerations. First, the agents possess local knowledge of the network and have a limited functionality, since only agents of limited size and complexity can migrate efficiently in a network and have little overhead. Hence, specific services are required that aim at deploying mobile agents efficiently in the system and the network.

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Second, mobile agents are subject to strong security restrictions, which are enforced by the security manager. Thus, mobile agents should find services that help to complete security-critical tasks other than execute code that might jeopardize remote servers. Following this trend, it becomes increasingly important to give agents the ability to find and make use of services that are available in a network (Bettstetter & Renner, 2000).

Some of the mobile agent systems developed in the last few years are Aglets (Lange & Ishima, 1998), Voyager (Recursion Software Inc, 2005), Grasshopper (Baumer et al., 1999), Concordia (Mitsubishi Electric, 1998), and D'Agents (Gray et al., 2000). Research in the area of mobile agents looked at languages that are suitable for mobile agent programming, and languages for agent communication. Much effort was put into security issues, control issues, and design issues. Some state-of-the-art mobile agent systems focus on different aspects of the above issues (e.g., Aglets on security, D'Agents on multi-language support, Grosshopper on the implementation of the FIPA [FIPA, 2002], and MASIF [Milojicic et al., 1998] standard). However, few research groups have paid attention to offering an environment to combine the concept of service discovery and mobile agent paradigm. Most existing mobile agent systems require their programmers to specify agent migration itinerary explicitly. This makes mobile agents weak in their ability to sense their execution environment and to react autonomously to dynamic distributed systems.

In this article, we propose a new service discovery model DSSEM (discovery service via search engine model) for mobile agents. DSSEM is based on a search engine, a global Web search tool with centralized index and fuzzy retrieval. This model especially aims at solving the database service location problem and is integrated with our IMAGO (intelligent mobile agent gliding online) system. The IMAGO system is an infrastructure for mobile agent applications. It includes code for the IMAGO server—a multi-threading logic virtual machine, the IMAGO-Prolog—a Prolog-like programming language extended with a rich API for implementing mobile agent applications, and the IMAGO IDE, a Java-GUI-based program from which users can perform editing, compiling, and invoking an agent application. In our system, mobile agents are used to support applications, and service agents are used to wrap database services. Service providers manually register their services in a service discovery server. A mobile agent locates a specific service by submitting requests to the service discovery server with the description of required services. Web pages are used to advertise services. The design goal of DSSEM is to provide a flexible and efficient service discovery protocol in a mobile agent environment.

The rest of the article is organized as follows. The next section presents a brief background related to this article and discusses the problem of service discovery in mobile agent systems. The section Disvoery Services Via Search Engine Model (DSSEM) introduces DSSEM and compares it with several service discovery protocols (SDPs) currently under development. The comparison criteria include functionality, dependency on operating systems, and platforms. The section titled Service Discovery in the IMAGO system gives an overview of the design of service discovery module and integration with the IMAGO system. Finally, the last section provides some discussion and concluding remarks as well as future work.

BACKGROUND AND MOTIVATION

The general idea of distributed services is that an application may be separated from the resources needed to fulfill a task. These resources are modeled as services, which are independent of the application. Services do not denote software services alone but any entity that can be used by a person, a program, or even another service (Hashman & Knudsen, 2001). Service discov-

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