Chapter 22
Mobile Agents:
Concepts and Technologies

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ABSTRACT

Current technological advances and the increasing diffusion of its use for scientific, financial and social activities, make Internet the de facto platform for providing worldwide distributed data storage, distributed computing and communication. It creates new opportunities for the development of new kinds of applications, but it will also create several challenges in managing the information distributed on the Internet and in guaranteeing its "on-time" access through the network infrastructures that realize the Internet. Many researchers believed and still believe that the mobile agents could propose several attractive solutions to deal with such challenges and problems. This chapter presents the core concepts of mobile agents, and attempts to provide a clear idea of the possibility of their use by introducing the problems they cope with, the application areas where they provide advantages with respect to other technologies and the available mobile agent technologies.

INTRODUCTION

Mobile agents are autonomous software entities with the capability of dynamically changing their execution environments in a network-aware fashion and roaming through network nodes to carry out tasks on behalf of users (Cabri et al., 2000; Chess et al., 1997; Fuggetta et al., 1998; Karnik & Tripathi, 1998; Spyrou, 2004; Braun, & Rossak, 2005). In this way, mobile agent systems constitute a middleware supporting distributed and dynamic applications based on mobile agents. The main advantage of mobile agents is that they can significantly save bandwidth, by moving locally to the resources they need and by carrying the code to manage them. Moreover, mobile agents can deal with non-continuous network connection, and as a consequence they intrinsically suit mobile computing systems. Due to these features, they have been considered and are still considered

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as an enabling technology for mobile, wireless and pervasive computing and a possible means for coping with the challenges in managing the information distributed on the Internet and in guaranteeing its "on-time" access through the network infrastructures that realize the Internet.

This chapter has the goal of giving a complete introduction on mobile agents. In particular, it presents the core concepts of mobile agents and attempts to provide a clear idea of the possibility of their use by introducing the problems they cope with, the application areas where they provide advantages with respect to other technologies and the available mobile agent technologies.

BACKGROUND

The ideas and the work that contributed to the development of mobile agent technologies came from network based computing, distributed operating systems and multi-agent systems.

In fact, the idea of dispatching a program for execution on a remote computer is quite old. Usually, the motivation has been either that the local computer did not have the capacity to execute the program or that the remote computer had direct access to some resource such as an attached peripheral that cannot be efficiently exported via the network. Initially, such schemes were employed both to enable low power computers to submit batch jobs on mainframes (Boggs, 1973) and to control printers (Press, 1985), then some executable scripts were dispatched among networks of computers to permit distributed real time processing (Crowley-Milling et al., 1974; Ousterhout, 1994). An additional step towards mobile agents was fostered by the research done in the distributed operating systems area to support the migration of active processes and objects along with their state and associated code at the operating system level with the goal of improving the load balancing across network nodes (Jul et al., 1988; Douglas & Ousterhout, 1991; Thiel, 1991; Lea et al., 1993).

Agent, software agent and multi-agent system are terms that have found their way into a number of technologies and have been largely used, for example, in artificial intelligence, databases, operating systems and computer networks literature. Although no universally accepted definition of the term agent exists (Genesereth & Ketchpel, 1994; Wooldridge & Jennings, 1995; Russell & Norvig, 2003), the different definitions allow distinguishing between the features that all the agents should own and the features that some special kinds of agents should provide. In particular, an agent should be autonomous, because it should operate without the direct intervention of humans or others and should have control over its actions and internal state; it should be social, because it should cooperate with humans or other agents in order to achieve its tasks; it should be reactive, because it should perceive its environment and respond in a timely fashion to changes that occur in the environment; it should be pro-active, because it should not simply act in response to its environment, but should be able to exhibit goal-directed behaviour by taking the initiative. Moreover, if necessary, an agent can be mobile, showing the ability to travel between different nodes in a computer network; it can be truthful, providing the certainty that it will not deliberately communicate false information; it can be benevolent, always trying to perform what is asked to it; it can be rational, always acting in order to achieve its goals, and never to prevent its goals being achieved; it can learn, adapting itself to fit its environment and to the desires of its users.

MOBILE AGENTS

A mobile agent is a program which represents a user in a computer network and is capable of migrating autonomously from node to node to perform some computation on behalf of the user.