

Chapter 8.7

Component Agent Systems: Building a Mobile Agent Architecture That You Can Reuse

Paulo Marques

University of Coimbra, Portugal

Luís Silva

University of Coimbra, Portugal

ABSTRACT

One central problem preventing widespread adoption of mobile agents as a code structuring primitive is that current mainstream middleware implementations do not convey it simply as such. In fact, they force all the development to be centered on mobile agents, which has serious consequences in terms of software structuring and, in fact, technology adoption. This chapter discusses the main limitations of the traditional platform-based approach, proposing an alternative: component-based mobile agent systems. Two case studies are discussed: the JAMES platform, a traditional mobile agent platform specially tailored for network management, and M&M, a component-based system for agent-enabling applications. Finally, a bird's eye perspective on the last 15 years of mobile agent systems research is

presented along with an outlook on the future of the technology. The authors hope that this chapter brings some enlightenment on the pearls and pitfalls surrounding this interesting technology and ways for avoiding them in the future.

INTRODUCTION

A mobile agent (Chess et al., 1994; White, 1996) is a simple, natural and logical extension of the remote distributed object concept. It is an object with an active thread of execution that is capable of migrating between different hosts and applications. By using mobile agents, the programmer is no longer confined to have static objects and perform remote invocations but can program the objects to move directly between applications. In itself, a mobile agent is just a programming

abstraction: an active object that can move when needed. It is a structuring primitive, similar to the notion of class, remote object, or thread.

Two possible approaches for the deployment of mobile agents in distributed applications are:

- a. To use a middleware platform that provides all the mechanisms and support for the execution of mobile agents. The basic characteristic of platform-based systems is that there is an infrastructure where all agents execute. This infrastructure typically corresponds to a daemon or service on top of which the agents are run. All agents co-exist on the same infrastructure. When the programmer develops an application, he is in fact modeling different mobile agents, which execute on the platform. Typically, this is done by extending a `MobileAgent` class or a similar construct. In fact, some of the mobile agents may not even be mobile but just static service agents interfacing with other functionalities of the system. Examples include, among others, the SOMA platform (Bellavista, Corradi, & Stefanelli, 1999), D'Agents (Kotz et al., 1997), Ajanta (Tripathi et al., 2002), Aglets (Aglets Project Homepage, 2006; Lange & Oshima, 1998), and JAMES (Silva et al., 1999). This is by far the most common approach.
- b. An alternative approach is to provide the support for mobile agents as software components that can be more easily integrated in the development of applications. This approach is followed by the M&M project (Marques, 2003), described in this chapter.

In this chapter, we present the results of two major projects that have been conducted in our research group: JAMES and M&M.

The **JAMES** platform was developed in collaboration with SIEMENS and consisted of a traditional mobile agent platform especially optimized for network management applications.

Our industrial partners used this platform to develop some mobile agent-based applications that were integrated into commercial products. These applications used mobile agents to perform management tasks (accounting, performance management, system monitoring, and detailed user profiling) that deal with very large amounts of data distributed over the nodes of GSM networks. With this project, we learned that this technology, when appropriately used, provides significant competitive advantages to distributed management applications.

The main motivation for the second project, M&M, was to facilitate the development process and the integration of mobile objects within ordinary applications. M&M abandoned the classic concept of mobile agent platforms as extensions of the operating system. Instead, this middleware is able to provide for agent mobility within application boundaries, rather than within system boundaries. Its objective was to demonstrate that it is possible to create an infrastructure such that the mobile agent concept can be leveraged into existing object-oriented languages in a simple and transparent way, without interfering in the manner in which the applications are normally structured. In order to achieve this goal, a component-oriented framework was devised and implemented, allowing programmers to use mobile agents as needed. Applications can still be developed using current object-oriented techniques but, by including certain components, they gain the ability to send, receive, and interact with agents. The component palette was implemented using the JavaBeans technology and was, furthermore, integrated with ActiveX (Box, 1997; Denning, 1997), allowing programmers from any programming language that supports COM/ActiveX to take advantage of this paradigm. To validate the soundness of the approach, a large number of applications have been implemented using M&M. Two application domains were of particular interest: agent-enabling web servers (Marques, Fonseca, Simões, Silva,

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