Enabling Mobile Agents Interoperability Through FIPA Standards

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Abstract. Mobility offers important advantages to information agent applications, specially those related to information retrieval. However, problems like security and interoperability are important barriers to the adoption of this technology. This paper focuses its attention to interoperability. Over the years, several solutions for mobile agents have been proposed, but each one covering specific problems leaving others unsolved. In this paper we analyse the problem of interoperability of mobile agents as a whole. We present an approach based on the use of FIPA ACL as the foundations to reach interoperability between different mobile agent system implementations at different levels. The implementation of the proposed solution has been adopted by JADE as the default mechanism to move agents among platforms and it has been widely used by its community.

Keywords: Mobile Agents, Interoperability, FIPA, JADE, Code Mobility.

1 Introduction

Mobility is a feature from which information agents can get a lot of benefits. For instance, information retrieval applications [5] show that agent mobility enables a uniform, distributed, autonomous and efficient way to process vast and heterogeneous amounts of information at Internet scale.

However, mobile agent technology seems not to be mature enough, having a set of core problems braking its adoption [21]. While great part of the community tends to think that mobile agent-based infrastructures could help building powerful and flexible distributed applications, everybody concludes that current knowledge is not mature enough to solve some of the main challenges presented by this technology.

In the development of mobile agent-based applications we are facing two main problems: security and interoperability. Security is mandatory in any reliable application based on mobile agents. No commercial application will be built until security in mobile agents can be assured. However, the lack of applications also causes a lack of security requirements, which forces researchers to build holistic security models trying to cover all security threats.

Interoperability is also an important problem for this technology. Since the initial proposals of mobile agent systems, a wide number of platforms have been implemented.
The platforms, typically developed by research groups, focus their implementation on several areas of mobile agents research. While some of the platforms focus their implementation on bringing security, others try to build high-performance mobile agents, methods to attain resource access control, communication among agents, and so on. These differences in these platforms design goals cause differences in programming languages, architectures or patterns chosen to design the frameworks and, also, the use of different communication protocols to transport agents or messages among platforms. This set of heterogeneous platforms is one of the main obstacles to agent interoperability and movement through different platform implementations. This fact is critical in some mobile agent applications, specially on the information retrieval ones, where a great number of reachable platforms are supposed to be present, each one with several resources for agents.

These interoperability problems also concern security because there is no standard set of protection mechanisms for mobile agents. Moreover, some of these protection mechanisms proposed in the literature, restrict the possibilities of interoperability among agent systems, as we showed in [2].

In the security area, several issues are well known and there are some protection mechanisms to face them. Other problems have no solutions yet, but a clear scenario of threats and possible vulnerabilities has been defined [14]. Probably, security in mobile agents has reached a limit where it needs more inputs from application requirements in order to produce effective protection mechanisms. In contrast, the case of interoperability is not like this.

Although several proposals have been presented to provide interoperability among mobile agent systems, this is not an area with as much maturity as in security. In the following sections different research works trying to cover interoperability are discussed. Most of these works are focused in software engineering techniques to provide portability of agents between platforms. However, these works often suppose a common programming language and a common communications infrastructure. Others like IEEE FIPA [10] (Foundation for Intelligent and Physical Agents), try to standarize some aspects of communication between mobile agent platforms to provide a minimum degree of interoperability to those systems implementing this standard. Finally, standardisation efforts also come from OMG with MASIF [17] (Mobile Agent System Interoperability Facility). This is an specification based on CORBA (Common Object Request Broker Architecture), which uses a standard communications and distributed objects infrastructure to attain interoperability.

From all reviewed works, there is no aim to properly define mobile agents interoperability, a complex capability affecting the different levels at which mobile agents can interact, and at which different degrees of interoperability can be reached using current techniques. Moreover, most of the research works provide partial solutions to specific problems, sometimes leaving others aside.

Our goal in this paper is to present all the issues related to interoperability of mobile agents, defining it, reviewing proposed solutions and presenting a global approach to the interoperability problem based on the use of FIPA standards. The main reason presented for such an approach is that important interoperability problems solved by FIPA