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Mobile agent standards and available platforms

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Abstract

This paper examines the current status of standardization efforts concerning mobile agent technology and presents five Java-based mobile agent platforms. Standards directly relating to mobile agent technology are presented first, followed by an overview of other standardization efforts that while not directly relating to mobile agent technology, can still contribute significantly to its success. This is followed by a detailed presentation of five Java-based mobile agent platforms. The description of each platform examines its communication mechanisms, its architecture and the services that it offers to a developer. The presentation of the platforms ends with a comparative overview of their features accompanied by a brief presentation of some performance results. The paper concludes with some general remarks on the future of this technology.

Keywords: Mobile agent technology; Mobile agent platforms; Mobile agent standards; Mobile agent platforms performance

1. Introduction

Mobile agent computing is an extension of the traditional methods of the remote dispatch of script programs or remote submission of batch jobs. It is however significantly enhanced over these two methods in that mobile agents incorporate more logic,are able to react to external stimuli and can exhibit more dynamic behavior since they can themselves control their migration and execution process. General overviews of the mobile agent technology (MAT) can be found in [4,12,13,18,24]. This paper assumes that the reader is familiar with the basic concepts of MAT.

The applicability of mobile agents in telecommunications especially in the fields of active networks, Intelligent Networks (IN), network management and mobile networks has been recognized by many researchers [5,10,16,17,20,22,23,43]. Generally, mobile agents are being contemplated as a viable alternative to traditional client–server computing both because of their advantages with respect to social ability and responsiveness and their offerings in terms of increased performance and robustness. It is generally faster and more reliable to engage in an intense dialogue after both communicating peers reside on a

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single machine (because one or both of them have migrated to a common location) than to conduct the same dialogue remotely. Use of mobile agents has also been envisioned in future mobile networks for support of advanced service provisioning in general and as regards personal communications, personal mobility and Virtual Home Environment (VHE) support in particular [3,6,7,9,14]. Furthermore, roles for Mobile Agents (MA) have been suggested in the field of media access over the Internet [19].

This paper is structured as follows. Section 2, ''Enabling standards for MAT'' examines the current state of standardization efforts that promote interworking between Mobile Agent Platforms (MAPs) or pave the way for their introduction into telecommunication environments. Section 3, ''Java-based mobile agent platforms'' provides a comprehensive and in-depth coverage of five Java-based MAPs. Section 4 is a concise, comparative overview of Section 3 accompanied by some performance results. Finally, Section 5 concludes the paper.

2. Enabling standards for MAT

Mobile agent technology is a relatively new industry and its further growth can be seriously impeded, if appropriate standards are not developed. There are two types of standards that can directly or indirectly benefit MAT.

- The most obvious and straightforward type is standards aiming at interoperability between different vendor's MA platforms [11].
- A second type of standardization efforts can indirectly contribute to the success of this technology: efforts that promote the integration of traditional telecommunication and modern computer networks, while not necessarily making any provisions for MAT per se.

This second type of standardization effort is a more subtle, long-term process, but has the potential of offering equally significant benefits for MAT. The mobile agent paradigm is a novel concept even in the context of data networks. It can not be applied in traditional telecommunication systems as they are today. However, the integration of legacy telecommunication environments with computer network technologies, like distributed object processing, will pave the way for the injection of mobile agents into this new environment. In a sense the ongoing convergence of computer-based communications and traditional telecommunications is more of a penetration of the former into the later. MAT needs a compatible environment to operate in and this penetration has the prospect of providing one. While this is a process of far greater proportions than simply providing hooks for MAT, it has the potential of facilitating MAT applicability in a broader range of legacy environments and in a way much more seamless than the explicit addressing of mobile agent issues could. Moreover, Distributed Processing Environment (DPE) technologies like CORBA (Common Object Request Broker Architecture) [41] can be very effective in dealing with problems related to the ''legacy'' characteristics of the telecommunication systems. For example, traditional switching systems are based on targeted application software and operating systems providing specific functionality. The separation between interface and implementation which is the cornerstone on which the CORBA specifications were built, guarantees that a Mobile Agent (MA) platform operating on top of a CORBA environment will not need to take into consideration integration problems deriving from the interworking with specific/dedicated environments.

In Sections 2.1, 2.2 existing standards and standardization efforts that fall in each of the above categories are addressed in more detail.

2.1. Interoperability standards

In the last few years, a number of vendors have shipped mobile agent platforms. Unfortunately these platforms differ widely in architecture and implementation and do not interoparate. Currently the following interoperability standards exist:

- The Mobile Agent System Interoperability Facility (MASIF) specification from the Object Management Group (OMG) specifies functional interoperation between mobile agent platforms [26,28].
- The Knowledge Query and Manipulation Language (KQML) developed as part of the ARPA Knowledge Sharing Effort can be used for knowledge sharing between agents [2,21,30].