Service-Oriented Framework for Virtual Organizations

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Abstract — This paper analyzes the main threats that should be addressed in order to develop open multi-agent systems. In this context, we are particularly interested in the design of the kind of system. Nowadays, suitable tools need to support organisations and, consequently, they are not suitable for the development of real open multi-agent applications. The THOMAS multi-agent framework has been proposed in order to tackle with all these open issues. It provides a unified framework for the development of virtual organisations, on the basis of a service-based approach.

Keywords: Service-Oriented Architecture, Open Multi-Agent Systems, Virtual Organizations.

1. Introduction

Virtual Organizations (VOs) are a set of individuals and institutions that need to coordinate resources and services across institutional boundaries [1,2]. They are open systems formed by the growing collaboration of heterogeneous organizations and entities. VOs are based on a separation between formal organizations that require defining how a behavior will take place. The methodology of multi-agent systems (MAS) and dynamic agent organizations is particularly well suited as a support for these open systems. The main features of VOs are: (i) they are populated by heterogeneous agents which can enter or leave the system dynamically; and (ii) they are deployed in dynamic environments. As a consequence of the heterogeneous features, organizations are needed to achieve the coordination in the system. In addition, system functions should be realized as services in order to allow heterogeneous agents or other entities to interact in a standard way. Moreover, the potential changes in the dynamic environment might require the adaptation of the structure and functionality of the organization. Furthermore, the highly adaptive needs of the system in the distributed environment require the application of knowledge discovery techniques and reasoning and planning mechanisms to resolve problems in an ad-hoc way. The integration of MAS and Service Technologies has been proposed as the basis for these new and complex systems [3]. In this series, both technologies can complement the strengths of each other: (i) service-oriented provides an infrastructure for the interaction among agents; (ii) MAS offer a more general and complex notion of Service Oriented Architecture (SOA) and its intelligent and social capabilities of agents allow defining complex services.

Moreover, according to current approaches, it is necessary to improve the coordination mechanisms in VOs by means of locating and composing services, both symbolic and semantic. The existence of adaptive mechanisms for creating organizational structures that allow optimizing the coordination in VOs, linking the agents in VOs allowing them to access services, both symbolic and semantic. The services-oriented framework in (i) defines the interaction between agents and services (ii) act as essential units. Thus, it is necessary to provide both mechanisms that, based on certain measurable criteria, would be able to find adequate services to VOs and (iii) provide the adaptation to the changing service conditions. The consequences and the requirements in the existence of regulatory mechanisms that allow a dynamic and efficient coordination in open systems taking into account the availability of the services and acting as a support for these open systems. The present paper represents a step forward in these open issues, providing a service-oriented framework specifically designed for the creation of virtual organizations and based on the THOMAS architecture [4].

This paper is structured as follows: Section 2 outlines the main issues of the THOMAS approach; Section 3 describes the THOMAS architecture. Section 4 presents a case study framework, in collecting and organizing its implementation. An application example of the THOMAS framework is shown in Section 5. Finally, conclusions are presented in Section 6.

2. Related Work

Virtual Organization design and implementation: Recent studies have shown that agent-based models that offer new possibilities and methodologies to design open MAS, focused on the organizational aspects of the agent society. Some examples of these approaches are AOR [12] and AOR++ [13]. Moreover, the software tools do not only focus on the management of organizational structures during the design process, but also on the operation of open MAS running on E-Infrastructures: E-MosaiC [20] and MOXIE [24]. However, the design and tools currently available are still not strong for many kinds of open MAS that deal with real world problems. Most of these tools work in a certain way, incompatible as they do not include all the phases and requirements for the entire development of systems of this kind.

The new client agent (CA) requests the SearchService in the ID component so as to find services of its interest (message 3). The result of this service is shown in message 4. Then, CI enquires in order to know which organizational unit (open MAS) the service is provided (message 5 and 6). CI must acquire the Gateway in order to request this service (messages 7 and 8). Once CI plays the role of CI, it will request the service in order to know who the service provider is and how this service can be accessed (message 9). The message 10 is sent to the service provider so that CI can forward the service to the client (message 11 and 12). The implementation has used two different providers (CRE and CHD). CI chooses to make a service request to CRE, as, according to our service process, CI sends a message for requesting this service (message 13 and 14).

6. Conclusions

As explained in this paper, the available agent platforms seem to be not suitable for the development of large scale open multi-agent systems, as they do not support managing their complexity, autonomy and dynamics in an efficient way. Thus, a new service-oriented framework for supporting the development of real VOs named THOMAS framework, has been proposed. It excludes the previous problems taking in account the changing development of open systems. Therefore, the main features of the THOMAS framework are: (i) it gives support to virtual organizations as a structural middle providing the autonomous behaviors of agents; (ii) it defines the coordination of processes through service composition and facilitates the management of the organization in a standard way; (iii) it provides a description and simulation services for allowing central agents, which have been designed independently of the THOMAS framework, to participate in the process; (iv) it provides mechanisms, i.e. some services, for the adaption and composition of the structure and functionality of the organization in response to the environmental changes. In this sense, it allows agents to recognize the system dynamically. This paper contains a general overview of the THOMAS framework and a detailed description of its main components (S and CHD). As a case study, which illustrates how an external agent is capable of discovering and employing functionalities in THOMAS, it is also provided. All this work has been included in an available prototype of the THOMAS distributed architecture.

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