Fuzzy Organization of Self-Adaptive Agents Based On Software Components

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ABSTRACT

This paper addresses the development of organizational multi agent systems as a preferred solution to develop open, distributed and adaptive application. It proposes a combination between components and agents to define a flexible organizational model of MAS based on three concepts: roles, self-adaptive agents based on components and fuzzy groups. Roles are played by agents in fuzzy groups. A fuzzy group is a fuzzy set of agents characterized by a membership function expressing the partial membership of each agent to the group. The membership function expresses the degree of capacity of each agent to play a role. This work proposes a fuzzy measure of the capacity of agents to play roles. It proposes a model of auto adaptive agents constructed by automatic assembly (reassemble) of software components. Components implement required capabilities to play roles. The proposed model and introduced concepts have been tested using the Madkit platform.

Keywords: Adaptive Application, Agent, Fuzzy Set, Group, Madkit Platform, MAS, Organization, Role, Software Component

1. INTRODUCTION

The wide spread of Internet and Web technologies as well as the presence of means of data processing in the majority of equipment around us, have increased the need for the development of distributed, open and adaptable applications. The development of such applications needs special means, and which could provide solutions that meet all the characteristics related to distribution, openness and adaptability which impose to applications to be implemented as a set of entities, executing on remote machines with distribution of computing and decentralization of resources and knowledge; to obey rules of interoperability; to be able to change boundaries by adding or removing entities and to react to the changes in their environments by performing modifications on the elements

DOI: 10.4018/ijiit.2014070103
or on the existing links between elements that constitute applications.

Software components (Szyperski, 1998) and multi-agent systems present important approaches among several applicant trends for this purpose. Both approaches provide abstractions to organize the software as a combination of software elements and have important qualifications which allow them to contribute to the development of distributed, open and adaptable applications. However, each paradigm focuses on different aspects of distributed applications and so they might be complementary.

Components and MAS guarantee a flexibility of the coupling between various entities as well as high levels of abstraction. Components differ with regard to the previous technologies with more important granularity and by the composition. MAS favor the manipulation and the making explicit of the knowledge and concepts as beliefs, goals, and mental states rather than data. Besides their manipulations, these concepts are also communicated and exchanged between agents. The social dimension of MAS pushes away even farther the abstraction. The design guided by the organization makes later the questions of implementation. Besides, concepts of very high level of abstraction such as roles, groups of agents, mechanisms of reorganization are manipulated. Concerning the flexibility of the coupling between entities, components drive an improvement for the structural coupling by the outsourcing of the references and by their explicit descriptions under the shape of provided and required interfaces. The manipulation of the coupling becomes so explicit and external in the software entities contrary to the previous technologies. For example, in the object paradigm, an object references another one by having an attribute which the value is the identifier of the referenced object; this situation involves changes in the object whenever modifying connections. The explicit architectural vision brought by the components is also a considerable gain regarding abstraction coupling since the focus is on the logic of coupling between components regardless of their internal implementation. MAS push even farther the organization of the coupling through several mechanisms allowing the collaboration of several entities, as well as the manipulation of the knowledge like organizations, tasks and plans. Also, MAS propose a semantic coupling guided by the knowledge and by the social organization contrary to the components where the coupling is mainly syntactic. The abstraction of the agent towards a role in organizational MAS based on roles, allows a more generic description of the application architecture as well as the relationships and interactions between agents. By playing a role, agents reference in an indirect and implicit way all agents performing this role. In this way, the structural coupling is external in the same way as for components, but with a degree of implicit furthermore with regard to the explicit connections between components. The mobility of agents influences the quality of applications by reducing the number and the volume of distant interactions and by improving the fault tolerance, effective solutions for agent deployment like (Hamidi & Vafaei, 2009) are proposed in this respect.

The characteristics related to the openness and adaptation meet well the characteristics of MAS. The interoperability and the control of agents are partially approached by problems of communication languages and protocols between agents. Agent’s approaches offer several potential solutions for issues related to the adaptation and means by which agents enter, integrate and leave systems. The adding and the removing of entities find a direct correspondence in component’s approaches proposing mechanisms to reconfigure dynamically applications which present real solutions for adaptability.

Existing approaches in which components and agents are combined didn’t exploit all the strength of both approaches, particularly the MAS organizations. We are searching for an adequate combination of components with agents in which we take the advantages of important contributions and strong points of both approaches. We propose a combination of components with agents in which we exploit the concepts of organization and roles (Odell,
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