Chapter XVI
Multi-Agent Systems for Semantic Web Services Composition

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ABSTRACT

The vision which is making its way in information technology is to encapsulate organizations’ functionalities within appropriate interfaces and advertise them as one or more Web services, which could be integrated, when brought into play, in workflows. This innovative idea brings with it new outstanding opportunities but also new great issues, related mainly to the ability to automatically discover and compose Web services. Several researchers belonging to the agent community are convinced that this technical area is a natural environment in which the agent technology features can be leveraged to obtain significant advantages. This chapter is aimed at briefly recalling the major results achieved by agent community and showing how their exploitation in the area of service-orientation systems could be very promising.

INTRODUCTION

Industry has been and still, more than ever, is interested in executing business functions that span multiple applications. This demands high-levels of interoperability and a more flexible and adaptive business process management. Most of the technology and market research companies, which provide their clients with advice about technology impact on business and consumers, agree on the fact that the adoption of a SOA paradigm is strategic and should be part of the most
forward-looking software projects. Nevertheless the paradigm shift is still quite challenging.

Many researchers belonging to the agent community are convinced that this technical area appears to be a natural environment in which the agent technology features can be leveraged to obtain significant advantages. Multi-agent systems, in fact, can play an important role in a service-oriented scenario, by efficiently supporting distributed computing and the dynamic composition of Web services. It is plain, in fact, that service-oriented technologies cannot provide by themselves the autonomy and social and proactive capabilities of agents. Agents, taking advantage of their social ability, exhibit a flexible coordination that makes them able to both cooperate in the achievement of a global goal and compete in the distribution of resources and tasks. However, what comes out is that the agent technology has to be appropriately engineered and integrated with other key technologies in order to provide a real powerful approach, combining ubiquity, context-awareness and intelligence. Driven by such motivations, a number of research works have been undertaken with the aim of tackling the problem of integrating service-oriented technologies with multi-agent systems.

This chapter has the goal of reporting a synopsis of these works and providing evidence of why multi-agent systems may be considered one of the most promising technologies for semantic Web services composition.

**BACKGROUND**

The first subsection includes a brief survey of the literature in the areas of standard Web services, workflow and semantic Web services technologies with the objective of showing the scenario in which the agent possibly contribution should be set and at the same time to give a short preamble acting as a motivation and rationale of the research work done by the agent community.

There are plenty of papers on the subject of agent and multi-agent system definition. The purpose of the second subsection is not to be comprehensive but simply to establish some basic concepts.

**Service-Oriented Applications: State of the Art**

The new vision of a Web constituted by dynamically interoperating nodes and the ever increasing demand for high-levels of interoperability by organizations that want applications to have broader reach, have stimulated the rapid growth of novel standards, technologies and paradigms with the aim of giving an answer to such problems. The most appropriate response to this need seems to be a service-oriented architecture (SOA), i.e. a system assembled from a loosely coupled collection of services and in particular of Web services—the integration technology preferred by organizations implementing SOA.

The basic specifications of Web services provide the infrastructure that supports the fundamental operations of a SOA. They are based on XML and define layers of abstraction including the message format description and communication protocol (SOAP), the operations performed by Web services and the related messages exchanged (WSDL), publishing and discovery capabilities (UDDI). This allows accomplishing an explicit agreement on the way Web services interact, providing a basic service-oriented middleware which can be exploited by possible higher layers enabling the realization of an effective SOA.

While Web services may be used in an isolated way to accomplish a specific business task, the need to aggregate multiple services in a new single meaningful composite service or to integrate them as part of workflow processes is more and more felt. During the last years a lot of research works have been undertaken, ranging from theoretical foundations, standardization efforts to concrete tools, technologies and real-world application case