Agent-Based Computing for Enterprise Collaboration
Synergies of Agents and Services

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Abstract

The sixth "Agent-based Computing for Enterprise Collaboration" workshop at WETICE 2008 focused on the areas of: agent-based semantic composition of Web services; agent-oriented software engineering methodologies and tools; and large scale multi-agent systems. The intention of this workshop was to bring together researches in the fields of software agents as they relate to the context of enterprise collaboration. This report briefly discusses the content of the papers presented at the workshop by respective authors. Moreover, the report ends with a summary of the main issues and challenges touched during the concluding discussion session.

1. Introduction

All well-known and appreciated characteristics of software agents, e.g., autonomy and proactivity, have greatly enhanced automation in many operational domains. The emerging area of service-oriented computing is an operational setting that crosscuts a large number of such domains. Enterprises can advertise their capabilities and data as services and inter-enterprise collaboration can be achieved as a composition of interoperable services. The widespread adoption of the ideas behind the notion of Service-oriented Architectures (SoAs) will soon promote the accessibility of large numbers of services openly available over the Internet. Software agents will be the crucial technology needed to fully exploit the possibilities of such a huge amount of services. We argue that the synergy between agents and

services will be one of the cornerstones of next-generation computing and today we are expected to build it up to its full potentials.

The synergy of agent-enacted collaboration and SoAs is extremely important because it is expected to effectively support and enhance paradigms like Computer Supported Collaborative Work, Workflow and Supply Chain Management, Automation in Virtual Enterprises, and Automated Distributed Component Composition. The purpose of this workshop series is to explore research that tries to bring together these ideas in the scope of collaborative inter-enterprise domains, i.e., where enterprises work and collaborate thought their respective IT systems.

This workshop on Agent-based Computing for Enterprise Collaboration (ACEC 2008) is a continuation of earlier workshops: WETICE 2003 in Linz, Austria, WETICE 2004 in Modena, Italy, WETICE 2005 in Linkopping, Sweden, WETICE 2006 in Manchester, UK, and WETICE 2007 in Paris, France.

In the following sections, we summarize the papers presented at the workshop. Two main threads were identified: agent-based software development, with a wide range of topics from methodologies to concrete tools; and agent-based service composition, which covered topics including semantic composition of Web services in open and large-scale multi-agent systems. The final section presents the discussions that culminated the forum.

2. Overview of the Papers

The paper "An Agent-based Approach for Composition of Semantic Web Services" by Ajay Bansal, Srividya

Kona, M. Brian Blake and Gopal Gupta concentrated on a novel technique for agent-based semantic composition of Web services. Mr. Bansal reviewed the ideas of agent-based semantic composition of Web services, as proposed by leading industry approaches. He clearly showed that such approaches rely heavily on syntactical aspects for the tasks related to managing service-based business processes. As such, these approaches are limited since the true functionality of ambiguous capabilities (i.e., Web service operations) cannot be inferred. In order to overcome such a limitation, Mr. Bansal introduced novel approaches that disambiguate services by interleaving process-based control with semantic annotations. In his presentation, Mr. Bansal also introduced a generalized architecture where intelligent software agents control process-oriented composition that leverages the descriptiveness of semantics. An outcome of this work is the specification of a multiple agent system characterized by a query agent that interacts with multiple repository agents to perform business-oriented service composition.

The next paper "An Agent-Based Approach for Distributed Execution of Composite Web Services" by Rosa Anna Micillo, Salvatore Venticinque, Nicola Mazzocca and Rocco Anversa focused on a deployment scheme that supports a truly distributed and decentralized execution of composite Web services. Dr. Venticinque started his presentation with a structured review of the general scheme of Web service composition and he introduced background concepts, e.g., orchestration and choreography. Then, he proposed a distributed approach for orchestrated execution of complex business processes, which enhances the potential of Web Services composition. SCOTT, an agent-based Service COmposiTion Tool, focuses on the execution process of a composite service and it takes advantage of a decentralized execution engine. Such an engine is a peer-to-peer application architecture where agents are distributed across multiple hosts, while users still perceives it as a single system. The clever parts of such an engine are the so called Actuator modules, which collaborate to execute a complex service in a fully distributed and decentralized manner.

The next paper "Load balancing of Mobile Agents based applications in Grid Systems" by Rocco Aversa, Beniamino Di Martino, Renato Donini and Salvatore Venticinque concentrated on agent-based management of large scale Grids. Dr. Venticinque first framed the problem and he reviewed the use of mobile agents to develop advanced Grids. State-full migration helps distributing computation where data reside and among newly available and less busy machines. However, when mobile agent technology is applied to new kinds of interaction facilities, e.g., cloning and migration, it implies the use of a suitable agent platform, which is an additional software layer that affects system performances. Moreover, underlying hardware architecture affects the behavior of agent platforms in some unexpected ways. This motivates the work of Dr. Venticinque because it requires predicting the dynamics of workload distribution and monitoring system utilization in order to design effective load balancing strategies. Dr. Venticinque concluded his talk with the proposal of a novel software architecture that, using the results of system monitoring, applies a load balancing strategy to maintain threshold performances within a fixed range.

The Best Paper of the workshop was "Wolf – An Eclipse Plug-in for WADE" by Giovanni Caire, Marisa Porta, Elena Quarantotto, Giovanna Sacchi that describes a new tool capable of supporting the effective use of workflows in real-world multi-agent systems. Ms. Sacchi first described WADE, a software platform for the development of distributed applications based on the agent oriented paradigm and exploiting the workflow metaphor to define system logics. Then, she concentrated on WOLF, which is an Eclipse-based tool designed to support for the graphical definition of WADE workflows. Besides that, WOLF also helps developers in setting up an Eclipse project for developing and managing WADE-based applications. Finally, Ms. Sacchi focused on the graphical definition of workflows and showed how WADE can take advantage of WOLF in the definition of system logics by means of workflows.

The paper, "A software agents simulation methodology to evaluate distributed network management applications in telecom mobile networks" was authored by Filippo Neri. Dr. Neri first framed his work within the current (centralized) Network Management approach of mobile networks and he showed that it may lead to problems when trying to accommodate new services and network nodes. Next generation mobile networks proposed by 3rd Generation Partnership Project (3GPP) envision a flat network architecture comprising some thousands of network nodes, each of which will need to be managed, in a timely and efficient fashion. This consideration has prompted the research activity that Dr. Neri presented with the goal of finding alternative architectures meant to overcome the limits of current centralized approaches. One approach to deal with the increasing network size and complexity is to move from a single centralized Network Management system to a more distributed or decentralized approach where each Network Management application consists of a controller part and a set of distributed parts running on individual network elements. This approach however raises questions on how to measure and estimate the resource requirements when requested to plan and

distribute the Network Management applications in the mobile networks before production-time. Therefore, Dr. Neri described his PIRR methodology designed to measure resource requirements for distributed applications in mobile networks and he also presented notable experimental findings.

The final paper "Emergent chaotic behaviour in agent based manufacturing systems" was authored by Kamel Benaissa, Daniel Diep and Alexandre Dolgui. Dr. Benaissa discussed the concept of emergent behavior in manufacturing multi-agent based systems, and he presented novel tools used in the characterization of chaotic systems. Considering a simple multi-agent model already in use in a distributed flexible manufacturing project, Dr. Benaissa investigated how its dynamical behavior strongly depends on some parameters inherent to the negotiation rules of agents. He showed that, depending on the values of such parameters, chaotic dynamics may occur. Although limited to a simple production scenario, Dr. Benaissa provided a formal analysis of chaotic phenomena and suggested some ways to control chaotic behaviors.

3. Discussion

The discussion session of the workshop addressed several issues. Participants were interested in:

1. The use of agents for the composition of real-world Web services in the scope of open, large-scale systems;
2. The potential benefits and detriments of agents in the context of SoAs;
3. Some important challenges that were also identified and posted to the audience.

The following section summarizes the discussions of participants that attended the workshop.

3.1 Agent-based Service Composition

Participants agreed that the definition of the work service is quite loose. In some venues, services seem to be limited to Web services, but participants agreed that: the definition of service itself should incorporate techniques for dealing with capabilities; and implementation should span Web services, Java components, distributed/remote objects, or even human actors. Of great assistance would be a true definition of service in order to clarify the distinctions. This lack of understanding with regards to the definition of service makes it difficult for projects with similar goals to correlate their work, particularly if they work on domains within different research topics. Moreover, this lack of common agreement on what services are causes severe problem when trying to understand what real-world services may look like and how agents could be used to compose them effectively. Workshop participants agreed on the need of a concrete testbed exemplifying a set of services that agents are called to compose to provide an added value composite service. Such a testbed should be realistic enough to highlight all issues that we will face on the field in the near future.

3.2 Benefits and Detriments of agents in the scope of SoAs

Workshop participants generally agreed on the applicability of agents as high-level abstractions for treating SoAs. Agents incarnate the essence of services in SoAs and the use of agents as mere service compositors were generally considered lacking. Nonetheless, participants agreed that SoAs are implemented using technologies that are far more advanced than agent technology in terms of horizontal features, e.g., reliability and scalability.

3.3 Concluding Challenges

After the discussion, the workshop concluded with the discussion of some challenges for future research. Such challenges concerned the development of:

- A set of Web services to be used as concrete testbed for agent-based service coordination, not only in the intent of emphasizing the inherent difficulties of such a problem, rather to anticipate future needs of real-world services.
- A critical rethink of the basis of the problem of semantic composition because seamless integration of semantics in the scope of both agents and services is currently very limited.
- Guidelines describing the notable lacks that agent technology is called to fill before it can be considered a possible advancement over the technologies that we use today for the development of services in terms of non-functional requirements, e.g., scalability, reliability, security and privacy-awareness.

4. Acknowledgements