

SAGE: Software Agent-Based Groupware using E-Services

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ABSTRACT

Service-oriented computing (SOC) suggests that the Internet will be an open repository of millions of modular capabilities realized as web services. Organizations may be able to leverage this SOC paradigm if their employees are able to ubiquitously incorporate such capabilities and their resulting information into their daily practices. This paper presents an architecture, *Software Agent-Based Groupware using E-services* (SAGE), that incorporates the use of intelligent agents to help integrate organizational processes with web services. Our first steps toward the development of SAGE consist of an operational concept and middleware prototype (i.e. groupware plug-in) to mediate service-oriented information.

Categories and Subject Descriptors

D.2.11 [Software]: Software Engineering: Software Architectures – *domain-specific architectures*.

General Terms

Design, Experimentation, Standardization, Languages

Keywords

Service-oriented computing, agents, groupware, web services

1. INTRODUCTION

Service-oriented Computing (SOC) is a paradigm where the capabilities of network-accessible services (i.e. web services) can be easily searched by and integrated among multiple organizations. In this paper, we suggest that smaller specialized teams may also benefit from the incorporation of services available both among the team members and broadly throughout their enterprise or perhaps even from the Internet. It may be unrealistic for human stakeholders to search and track relevant services in the context of their job. Consequently, we propose the use of automated, adaptive software techniques (i.e. intelligent software agents), to facilitate the integration of human-managed processes and potential service-oriented capabilities. Furthermore, we characterize these techniques in the context of intelligence analysts that track individuals for the benefit of national security.

Although there are other agent-based approaches for groupware [3][4], this is perhaps the *first* study that attempts to integrate agent-mediated groupware with open services in context of evolving web services paradigms. Furthermore, we introduce a publish and subscribe technique [1] to *uniquely* implement three different interfaces, agent-to-agent (implicitly analyst-to-analyst), agent-to-web service, and agent-to-web information.

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2. ON-DEMAND COLLABORATION FOR INTELLIGENCE PERSONNEL

Under the sponsorship of the Air Force Research Lab (AFRL), new infrastructures, that support information sharing and advanced analytical collaboration, are being created to support intelligence analysts. Intelligence analysts typically issue or receive urgent requests for information. These requests spur the formation of a team of perhaps a dozen relevant experts who must construct accurate responses in a short period of time. Cognitive support tools employed will vary according to the shifting group membership. Although several forms of groupware software are used, the team formation and processes are relatively ad-hoc. Of benefit to this domain is the recent inception of SOC techniques. The architecture proposed in this paper addresses the coordination that must occur to integrate on-demand group collaboration with the use of external cognitive support tools using SOC. Table 1 describes the steps that an analyst leading a study would take considering the existence of SOC tools.

Table 1. Initialization Routine.

1. Lead Analyst (LA) is notified of a request for information
2. LA queries and locates other specialists across multiple organizations to contribute in the group setting.
3. LA establishes a collaborative workspace.
4. LA queries and locates services and informational streams that may be relevant to the study
5. LA establishes connectivity to the candidate services and information within the workspace

Table 2 shows the day-to-day requirements of a groupware system that incorporates services. Table 1 and Table 2 represent the core set of requirements that were used to determine an initial architecture for SAGE.

Table 2. Concepts of Operation.

On-Demand Operational Requirements (Reactive)

- Delivery of newly discovered information to the group
- Analyst-initiated search for services or information
- Standing request for information throughout the lifetime of the study

Next-Generation Proactive Requirements

- Ubiquitous identification of human processes and correlation to relevant services or information
- Execution of potentially relevant service and proactive delivery of the resultant information

3. THE SAGE ARCHITECTURE

The SAGE project is toward the establishment of general capabilities to allow human users to incorporate services into their group-oriented processes. In the context of the architecture, a lead analyst performs his daily procedures. SAGE agents would maintain a knowledge base consisting of keywords and historical actions of the analyst. Either through the request of the analyst or proactively, in the future, the agent queries other agents in addition to open service repositories to find information or relevant services. This architecture is illustrated in Figure 1.

SAGE application has currently been implemented in Beta form using the Java Web Services Development Kit, Jess rule engine, and WSDL4J (for integration with web service descriptions).

4. DISCUSSION

Although the use of agents in groupware is promising, very few projects exist. However, there are other agent-based groupware projects [3][4] that focus on the social effects of the human collaboration. This work takes a systems approach by addressing the ability to integrate human processes with external software capabilities. In future studies, we plan to experiment with the SAGE approach using a real-time simulated intelligence community.

5. ACKNOWLEDGMENTS

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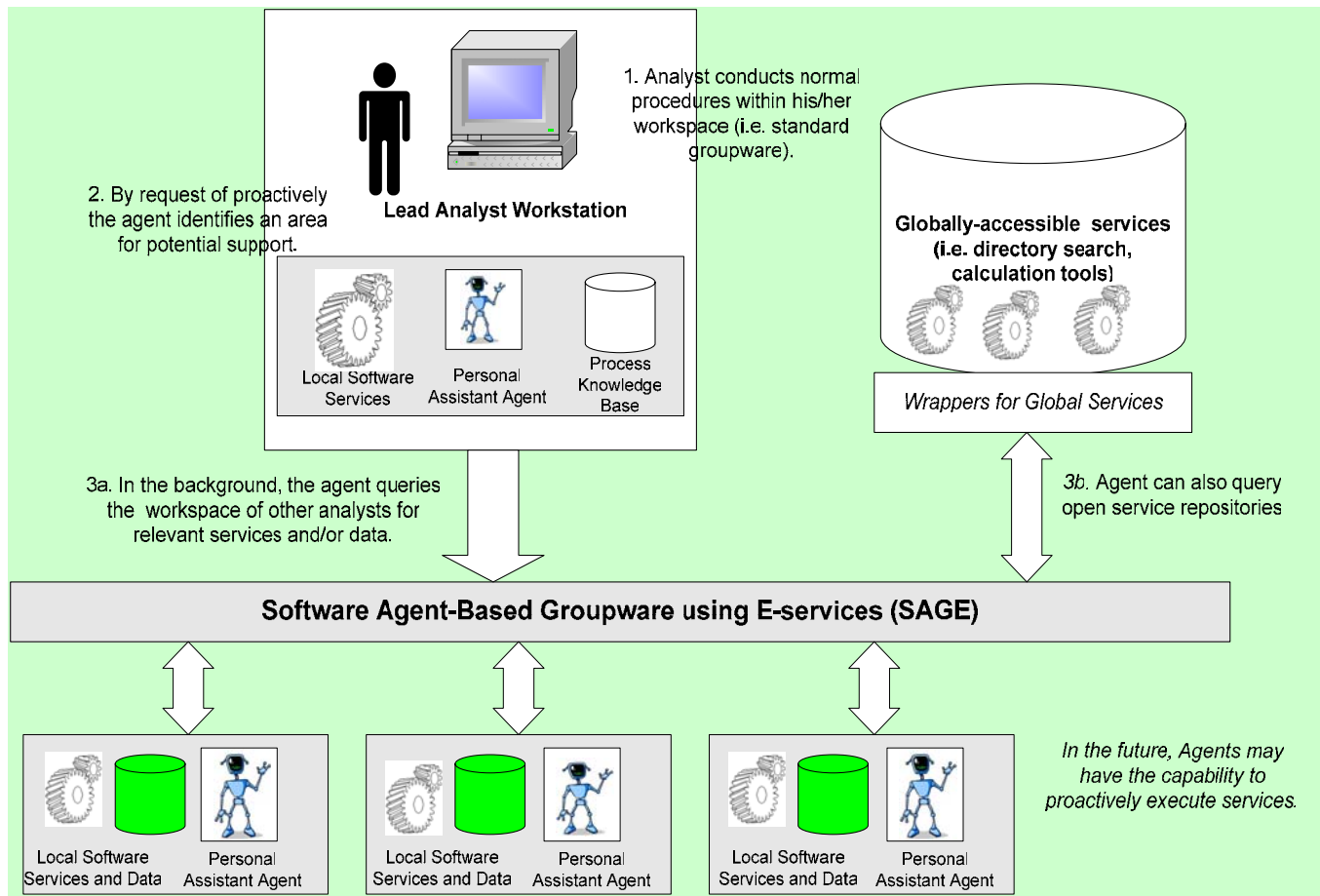


Figure 1. SAGE Architecture.