A SOA-BASED MULTI-AGENT APPLICATION FOR THE CROSSLINGUAL COMMUNICATION PROBLEM

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Abstract: We present a multi-agent system (MAS) approach to deal with the communication mediation among communities with disparate levels of language. Service-oriented architecture (SOA) is adopted as the basis for designing our proposal that has double purpose: (a) to present an alternative to the crosslingual communication problem and (b) to study an agent organization under the SOA specifications. A case is presented in which the communication among food consumers and experts in food quality/safety is carried out by means of agents' organizations. We specify two basic sets of elements: application agents, responsible for the logical information, and components that are in charge of persistency, interface, and communication among the software artifacts.

1 INTRODUCTION

Most of information systems currently developed is focused in Web applications. The Internet has opened a vast field of distributed applications that have changed definitely the enterprise environment, allowing an intense level of interaction among players that no one has ever realized. The ubiquity and the distributed and interconnected characteristics of Internet represent a natural field for multi-agent systems (MAS). Multi-agent systems present properties as autonomy and pro-activity that make them interesting for Web applications. The importance of Internet has led to efforts like MIX (Mediation of Information using XML) (Baru et al., 1999), that uses agents to integrate distributed information in disparate sources. The Web also can be seen as a big distributed database having XML (and its extensions or modifications) as an underlying data model.

A class of problems that can strongly benefit from these advances refers to the crosslingual communication, information retrieval, and computer-mediated dialogue. These problems involve information exchange among communities with disparate language levels and require solutions that preserve the accuracy of the exchanged information.

The crosslingual mediation problem is discussed by Piwek (2006), focusing the banking domain that requires an extremely high accuracy information exchange among the players. The problem approached here also refers to the information exchange in a context demanding a high level accuracy, in which distributed players are looking for a consensus regarding to a knowledge piece. The ideal

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solution for this problem is an automatic process to translate one language to other, being able to cope with the different semantic levels of each specific language. A solution to this problem is much more important considering the challenge to human-to-human communication through a browser. However, to build an effective automatic translator for this scenery is a dream far to be realized. So, the necessity of communication among communities is a reality that requires, if not the best solution, at least one viable solution. The solution we present uses the agents' technology to facilitate the negotiation among the communities' members.

We argue that it is a problem that can be naturally approached with the MAS technology. Agents can perform the roles required in mediation process. The described case study refers to a consumer that is in need for information regarding to a product. This information must be supported by scientific evidence and is generated by experts in the involved domain.

2 CASE DESCRIPTION

Our case study has as context a situation in which a food consumer needs to clarify a question regarding to a product. This consumer can access the system in any place (in home, in a supermarket, in a school, etc). It may need information about food that is not in the respective label or is unclear. We developed a solution for this problem in which (a) the answer for a consumer query may be available in a knowledge base and can be directly accessed by the system or (b) it is necessary to send the query to an expert domain network, able to respond it. The general context for this system is shown in Figure 1.

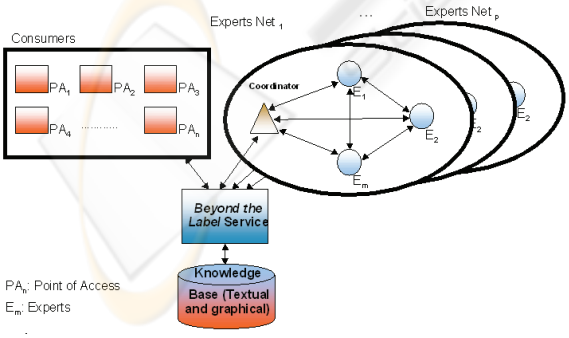

Figure 1: Application context.

There is in this structure a set of consumers, a number of experts' networks, a knowledge base and the MAS system that is responsible for the action coordination among the players. PA_1, PA_2, .., PA_n represent the customers requiring specialized information in non-technical language. E_1, E_2, …, E_m represent the experts that can provide technical answers to the customers questions. The triangle represents a set of communication specialists that are in charge of translating the technical language from the experts to the customer language. In order to enable its reuse, the answers are stored in a knowledge base. Notice that the information required by consumers are those not supplied by the product labels. For instance, a consumer may be interested in knowing about the effects on human health of a cereal produced from a genetically modified grain, or the difference between organic to hydroponics lettuce. In this case, a mediator agent will be responsible for building a consensus among the specialists addressed to provide a sound technical answer to the customer. This answer will be translated by the communication team, sent back to the consumer, and stored in the answers server. The interrelation among the players and the functionalities carried out are shown in Figure 2.

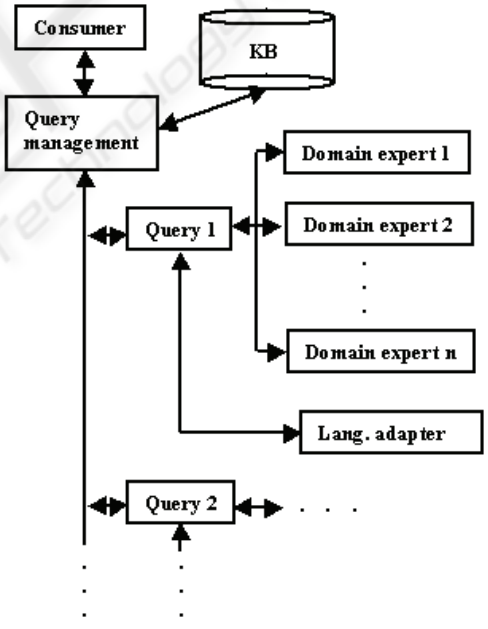

Figure 2: Interaction among the players.

The consumer question is generated during its interaction with the system. A *query manager* searches for an answer in the knowledge base. If the answer is found, the manager sends it to the consumer and finishes the process. If the question is not in the knowledge base, the manager starts an answering cycle.

3 THE MAS DESIGN

The MAS design was made using MIDAS (Haendchen Filho et al 2007), a MAS development framework specified under the service-oriented architecture (SOA). The platform is based on the coexistence of several containers, each one executing a JVM (Java Virtual Machine). It provides a complete execution environment in where agents can execute concurrently in the same host and communicate via web services with external heterogeneous platforms.

The mechanisms embedded in MIDAS work into two abstraction levels: (1) in the generic architectural level, providing infrastructure services, such as message transport (send/receive, pack/unpack, requests translate), the control over the platform and agents' lifecycle, tasks for services handling (services registry, publication and discovery), and (2) in the agents' design level, providing abstract classes that define the hot-spots from which specific features of the concrete agents (or components) can be implemented, wrapper components encapsulating Web Services and a blackboard to support the agents' communication model. The blackboard (Ferber 2000) is a software entity widely used in symbolic cognitive multi-agent systems. Its structure is defined to enable agents interact indirectly by sharing data and perceiving environmental changes.

At the design level, the following application agents must be developed:

Publisher: responsible for formatting and publishing answers to the consumers, identifying the different GUI devices to display the information.

1. QueryMgt: plays the roles related to requests receiving, proceeding to the matching between the user question and the expert profiles, looking for the best set of experts able to answer the question.
2. DomainExpert: created for each expert involved in the question answer, this agent is responsible to support the human expert in managing her/is answering process, maintaining all information relevant (e.g., the timetable to generate an answer and the experts´ names working together to find a consensus) to the process.
3. Consensus: its main role is to analyze the answers from the DomainExpert and control a coordination cycle until finding a consensus among the domain experts.

Beyond application agents, some components must be developed: The AnswerSearch component encapsulates the web services *getAnswerInKB* that retrieve information about knowledge base and *searchAnswerer* that retrieves a researcher able to reply the consumer question. Other components, such as data access objects and graphical user interface devices must also be implemented.

4 EXPERT/CUSTOMER MEDIATION

The application developed is named BeyondLabel (BL). The agents in the presentation and logical layer (Publisher, QueryMgt, DomainExpert, Consensus) interact with MIDAS (SOM, Blackboard). The sequence diagram in Figure 3 shows the actions carried out when a service request is sent from a user to obtain any product information. The players weakly shadowed represent application agents, while the darker ones are components of MIDAS.

The sequence of actions in BL starts when a service request is sent from a user. This action is performed in a GUI device and directed to the SOM agent. Following a typical SOA model, the agents do not communicate directly among them. The QueryMgt agent receives the service request via SOM, verifying first if an answer already exists in the KB. If so, the agent requests the *responseDirect* service that is forwarded by SOM to the Publisher agent and sent to publication. If there is no answer in the KB, the QueryMgt agent requests the *queryDirect* service that is forwarded by SOM to the DomainExpert agent that will proceed a matching between the user question and the expert profiles, looking for the best set of experts able to answer the question.

One DomainExpert agent is instantiated for each expert involved in the question answer. After receiving the technical response from the expert that may be a human or a software agent, the DomainExpert analyses the responses. If no divergence remains regarding to the answers, it is driven to SOM and forwarded to publication. If the DomainExpert agent detects any divergence, the message is written in the Blackboard.

The Consensus agent monitors the Blackboard and, when a message to him is there, it is recovered and the agent processes this message until finding a consensus. In case a consensus is not possible, the conflict information is sent to the administrator that will forward the problem to a set of experts in that domain that will discuss deeper the question. From this point, all interactions among the experts fall out of the system.

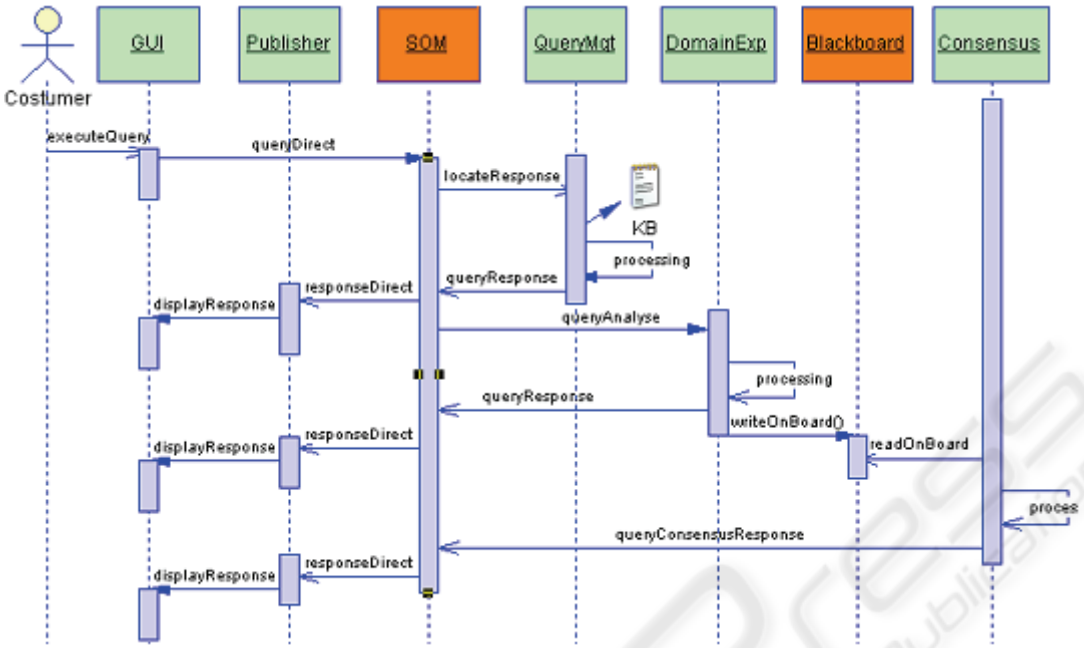

Figure 3: The sequence diagram for the expert/customer mediation.

5 FINAL REMARKS

In this paper the mediation among communities with disparate levels of language was approached by means of a SOA-based multi-agent application. Using a low coupling structure, the development becomes easier, since the application agents can be developed without concerns with other specific agents. Furthermore, the location transparence provided by SOA simplifies the development, making easier to perform local and remote services invocation. The application benefits from multi-agent approach since the human behavior of searching for consent on polemic issues can be easily mapped into agents. Considering that, even for simple domains, the automatic translation of different jargons is a far to be achieved reality, the solution involving human actors sounds to be an interesting one. So, we have modeled the solution by applying the MAS approach, controlling automatically the process while assuring the answer accuracy.

The ongoing work includes to scale the application to a broader set of consumers, involving some supermarkets networks.

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