Value-Added Services enabling Semantic Web Technologies for SMEs

A. Becks[1], **J. Huster**[1], **M. Jarke** [1,2], **A. Jertila**[2], **D. Kensche**[2], **C. Quix**[2], **C. Seeling**[1]
[1]FIT Fraunhofer, St. Augustin, Germany, *firstname.lastname*@fit.fraunhofer.de
[2]RWTH Aachen University, Informatik V, Aachen, Germany, *lastname*@cs.rwth-aachen.de

Abstract

The SEWASIE project (http://www.sewasie.org) focuses on the question how to assist networks of small and medium enterprises in enhancing their intra- and inter-organizational information management capabilities. While the project also includes novel techniques for semantic enrichment, query management, and presentation techniques in multilingual information acquisition from the web, this paper addresses the question how to further exploit the acquired information to support every day business processes; firstly, by linking it into more established decision support environments based on OLAP technologies; secondly, by using it as a basis to engage in negotiations concerning inter-organizational cooperation.

1 Introduction

The internet is a collection of information from various sources, some of which are structured sources such as databases, others are unstructured sources such as text, and others are semi-structured sources such as XML documents. The access and management of a variety of information sources is a challenging task. The semantic web aims at providing technologies to annotate information sources with ontologies that help to find the right information.

The SEWASIE project has implemented an advanced search engine that provides intelligent access to heterogeneous data sources on the web via semantic enrichment. The prototype provides users with a search client that has an easy-to-use query interface to define semantic queries. The query is executed by a sophisticated query engine that takes into account the semantic mappings between ontologies and data sources, and extracts the required information from heterogeneous sources. However, in the context of a business transaction, searching for information, products, or potential business partners is only one part of the transaction.

This paper presents two ways how the acquired information can be further exploited. Firstly, the query result can be linked into more established decision support environments based on OLAP technologies. Thereby, unstructured external information sources such as the web and structured company-internal data is integrated. Secondly, the information can be used as the basis for structured web-based negotiation with the goal to agree on a contract for a business deal.

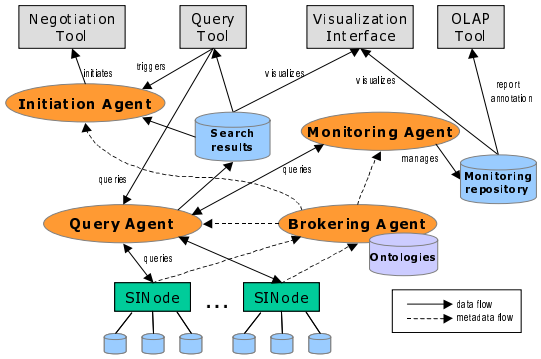

Figure 1: SEWASIE Architecture

Fig. 1 gives an overview of the architecture of the SEWASIE system. The user will normally start a session by specifying a query using the *Query Tool* [3]. Then, the query will be answered by one or several *Query Agents* (QA) which send the query to several *SINodes* (SEWASIE Information Nodes, [1]) and integrate the result [2]. The QA is supported in this task by a *Brokering Agent* (BA) which maintains the metadata of the SEWASIE network in form of inter-related ontologies. In particular, the BA provides information which kind of information is provided by which SINode. To do this, the BA integrates in a semi-automatic way the ontologies of the SINodes into a *BA ontology*. The BA ontology is of central importance as it guides the QAs to the relevant sources and provides the semantics for the data returned by the QA.

Around SEWASIE's search service a number of value-added services have been realized on which this contribution is targeted. Changes in the information space can be monitored over time by the *Monitoring Agent* (MA). The MA manages the collected results in the monitoring repository. The collected documents can be shown in the visualization interface or used to annotate OLAP reports (see section 2). The semantic information returned by the query agent can also be used to initiate a negotiation process. Therefore, the user can trigger an *Initiation Agent* in the query tool to start a negotiation with selected companies of the query result. An important feature of the initiation agent is that it uses the product constraints that have been specified in the search phase to initialize the first version of the contract for the negotiation phase (see section 3).

2 Visualization and Monitoring

The goal of the monitoring process is an active information feed for users regarding their long-term interests. Thus the monitoring service complements incidental searches by permanently observing potentially relevant information from documents on the web. Based on the user's domain model, the monitoring service makes use of SEWASIE's semantic search capabilities for retrieving and analysing relevant documents. This way, a personalized collection of semantically enriched and versioned documents is made persistent for the user's disposal.

The monitoring repository serves as an information backbone for different context-based access services: The user might use the monitoring user interface *MAUI* for concept-based browsing of the collection. Once having identified relevant documents, the user can dig deeper into the topic of interest and explore the document's context in terms of related documents. This is offered by the visualization user interface *SWAPit* [5] with its facilities for similarity-based browsing through multiple views. Alternatively, the user might intend to relate the gathered information to the internal business data model coming from her company's well-established OLAP tool. Searching for background information that helps to explain phenomena in internal data is a difficult and costly task. This task is surprisingly widely unsupported, although many internal key performance indicators have to be reconsidered in the light of external factors, i.e. the developments on supplier and consumer markets (does a 5% increase of jeans sales in the third quarter mean a good or a bad performance as compared to core competitors?). A patent-pending *annotation module* takes the OLAP report at hand and calculates a relevance value for each document. The relevance measure is composed by two components, a model-based analysis of document contexts and a syntactical analysis of document content.

Fig. 2 shows the overall process of filling and accessing the monitoring repository. The MA issues queries to the query agent and updates its repository with fresh contextualized results. The OLAP environment is feeded with annotation results from past to date. Different views make up the visualization interface which is used to display annotation results, search results, or the content of the monitoring repository.

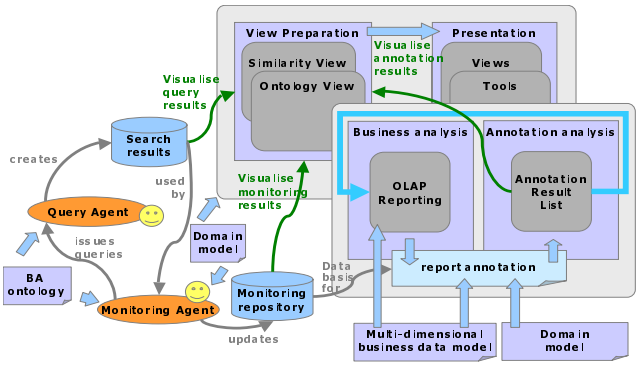

Figure 2: Visualization and Monitoring Component

3 Ontology-based Negotiation

The goal of the negotiation phase is the definition of a business contract. In this context, we consider complex negotiations about non-standardized products. This means that the price of the product is not the only negotiable item of the contract, but that other details of the contract (such as delivery, payment, product properties) can be negotiated as well. As all of these issues have to be defined in a formal way, ontologies can provide the basis for the definition of a contract. Thereby, misunderstandings and ambiguities can be avoided.

The negotiation tool in SEWASIE supports complex communicative exchanges through the exchange of semi-structured messages combined with effective document management. The tool is based on the negotiation support system *Negoisst* [4]. By exchanging messages, the business partners define a contract. In order to avoid communication problems and to enable formal reasoning about the contract, the common background is defined by ontologies. Our novel approach to ontology-based negotiations enables such negotiations on two levels. On the one hand, the business negotiation process, based on ontologies as the common terminology, is supported. This includes a negotiation about rules that guide the dynamic interactions following (partial) agreements. On the other hand, the ontologies can be extended by the negotiation partners if needed, which means that there can be negotiations about the ontologies themselves.

Fig. 3 illustrates the overall process of the business transaction and the roles of the various ontologies in this process. The result of a search (e.g. a list of companies providing a specific product) is the input for the negotiation process. The search also determines the context of the negotiation process, i.e. the user and domain ontologies. These ontologies can be refined and extended during the negotiation process and form together with a default contract ontology (e.g. concepts for delivery and payment) the *negotiation ontology*. The negotiation ontology is the basis for the contract negotiation and will be used to define the contract. Dynamic conditions can be captured by contractual rules (e.g. if the delivery is late, the price will be reduced).

Finally, in the fulfilment phase, the contract has to be executed. During this phase, the business partners have to fulfil their obligations specified in the contract (e.g. deliver the product or pay for the delivery). In the case of a violation of a contract rule, contractual penalties might come into effect. Therefore, the system monitors the fulfilment phase, i.e. records the actions made in this phase and derive the consequences using the rules specified in the contract.

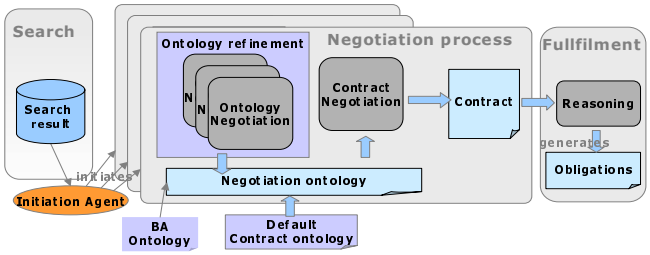

Figure 3: Architecture of the Negotiation Tool

4 Demonstration Overview

The demonstration is based on the scenario indicated in fig. 4. Note that also other "execution flows" are possible as it is depicted by the arrows in fig. 4.

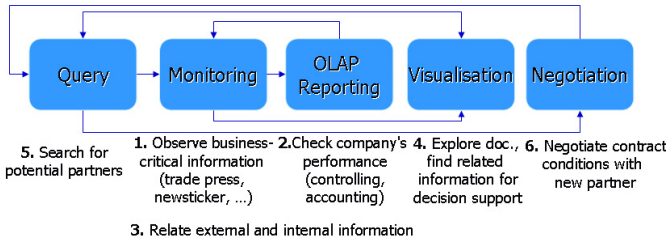

Figure 4: Demonstration Scenario

Suppose that a manager starts her working day with the observation of business-critical information collected by the monitoring service during the night, such as trade press or news ticker articles (step 1). Next, she switches to the OLAP tool to check the company's performance (step 2). For a comprehensive assessment of the company's situation, internal data from the OLAP tool needs to be related to external background information about markets and competitors (is the observed decrease in sales caused by an economic downturn of the branch or by high cost of the company's production factory?). Relations between internal and external information are calculated by an annotation service and presented in the visualization interface (fig. 5). The tool visualizes a number of documents (listed in upper right corner) in a document map (upper left corner). Documents which are semantically related can be found close together on the map. Furthermore, the tool links the dimensions of the OLAP model (lower right corner) to the concepts of an ontology (lower left corner). Thereby, it enables direct semantic queries from the OLAP tool, i.e. find all documents related to an OLAP report (step 4).

In the scenario, the user might have noticed that the decreasing sales are caused by lower prices of the competitors.

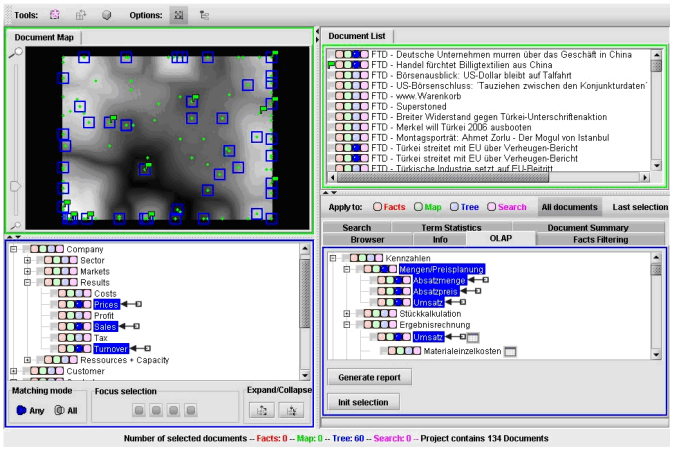

Figure 5: Monitoring & Visualization Interface

Figure 6: Ontology Based Negotiation

Therefore, the manager starts a search for new suppliers delivering products of a specific type (step 5). If the query returns a list of suppliers, the user can select a subset of them and start a negotiation (step 6). The negotiation is integrated into the system in several ways. Firstly, the information of the query (e.g. products and their constraints) are transferred to the negotiation tool and are integrated into the first version of the business contract. Secondly, the negotiation is structured and ontology based, i.e. the exchange of message follows a specific protocol and the contents of the messages is semantically enriched by relating it to concepts of an ontology (fig. 6). Finally, the content of contract is further formalized by adding rules to the contract. These rules represent contractual conditions which have to be applied if certain exceptions occur (e.g. reduced price in case of late delivery) [4].

Acknowledgements: This work is supported by the 5th Framework IST programme of the EU. We would like to acknowledge the support of all partners of the SEWASIE project, in particular Sonia Bergamaschi, Enrico Franconi, and Maurizio Lenzerini.

References

[1] S. Bergamaschi, S. Castano, D. Beneventano, M. Vincini: Semantic Integration of Heterogeneous Information Sources. *Data & Knowledge Engineering*, **36**(3):215-249, 2001.

[2] D. Calvanese, G. De Giacomo, D. Lembo, M. Lenzerini, R. Rosati: What to Ask to a Peer: Ontolgoy-based Query Reformulation. *Principles of Knowledge Representation and Reasoning (KR2004)*, 2004.

[3] T. Catarci, T. Di Mascio, E. Franconi, G. Santucci, S. Tessaris: An Ontology Based Visual Tool for Query Formulation Support. *16th European Conf. on Artificial Intelligence (ECAI-04)*, 2004.

[4] M. Schoop, A. Jertila, T. List: Negoisst: A Negotiation Support System for Electronic Business-to-Business Negotiations in E-Commerce. *Data & Knowledge Engineering*, **47**(3):371-401, 2003.

[5] C. Seeling, A. Becks: Analysing Associations of Textual and Relational Data with a Multiple Views System. *2nd Intl. Conf. on Coordinated and Multiple Views in Exploratory Visualization (CMV 2004)*, 2004.